ARCHIVES OF OPHTHALMOLOGY

VOLUME 26 (old series Volume 83) SEPTEMBER 1941 NUMBER 3

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CHAGAS' DISEASE

THE OCULAR CONJUNCTIVA AS THE MOST FREQUENT ROUTE OF INFECTION

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American trypanosomiasis, called Chagas' disease in honor of its discoverer, is a tropical disease frequently encountered in certain parts of the American continents, especially Brazil, Argentina, Uruguay, Peru, Venezuela, Paraguay, Bolivia, Guatemala and Panama. The organism which causes the disease is a flagellate protozoon. Carlos Chagas named the organism Schizotrypanum cruzi in honor of Oswaldo Cruz, a Brazilian scientist. Schizotrypanum cruzi is a habitual inhabitant of the Chiroptera. It is transmitted to man and animals by several Hemiptera of the Lamus genus, the best known of which are Lamus infestans and Lamus magistus, blood-sucking insects abundant in many sections of South America.

From articles recently published on the subject, it is evident that of the seventy species of blood-sucking insects of the Reduviidae family existing in America, twenty-six species are naturally infected with Schizotrypanum cruzi and four more species can be experimentally infected. The species of Lamus which infest various countries of North America, Central America and South America and which transmit trypanosomiasis can be counted by the dozens.

According to Nino, L. infestans occupies a great portion of Argentina, bounded by the Andes mountains in the west, by the shores of the Atlantic Ocean and the Uruguay and Plata rivers in the east and south and by parallel latitudes of 22 degrees in the north and 41 degrees in the south. However, the incidence of Schizotrypanum cruzi infection of the transmitting insects gradually diminishes nearer the southern and eastern borders of this territory.

About twenty species of insects of the Lamus genus were found to be naturally infected by Schizotrypanum cruzi in Venezuela. One

Read at the First Pan-American Congress of Ophthalmology, Cleveland, Oct. 12, 1940.

species of those insects is Eutriatoma nigroma geniculata, which lives 800 meters above sea level and was identified by Felix Pifano. The percentage of insects transmitting infection is as large among the insects of Uruguay, Paraguay and Bolivia as it is among those of Venezuela.

Carlos Chagas found in early investigations that Schizotrypanum cruzi may infect man and a large number of animals, especially certain species of tatous (armadillos), namely, Dasypus hibridus, Dasypus paraguayense, Dasypus novemcinctus, Dasypus sexcinctus and Dasypus unicinctus, all of which are infected in the proportion of 40 per cent by the infestans, geniculatus, magistus, pallidipennus and other species of Lamus. Several domestic animals, especially dogs, cats and sheep, are also reservoirs of the parasitic protozoa.

Chagas observed also that the acute reactions which mark the onset of trypanosomiasis are due to the presence of the parasitic protozoa in the blood. They generally occur in children who have always lived in houses infected with Lamus. In the course of the disease the protozoon leaves the blood for the tissues; then it can no longer be identified in the blood of the patients, except in rare cases, and the disease enters into the chronic stage. That is the reason why acute reactions appear in adults only in exceptionally rare cases. In almost all cases by the time the disease becomes apparent it is already in the chronic stage.

Several ocular diseases are included in the regional acute or chronic trypanosomal reactions. Palpebral edema, keratitis, conjunctivitis, pthisis bulbi, paralysis and some other conditions are frequently seen during the acute stage of this disease. Chagas reported a case of strabismus and inflammation of the ocular conjunctiva in a patient with the meningoencephalitic form of American trypanosomiasis of several days' duration. He also reported several cases in which grave palpebral, conjunctival and corneal lesions appeared during the acute phase of the disease and were sometimes complicated by panophthalmia with complete loss of the eye. He pointed out the frequency, in the chronic form of the disease, of corneal lesions, which varied from the formation of corneal opacity to that of adherent leukoma and were sequels of ulcerative keratitis which occurred during the acute stage of the disease. In some cases bulbar atrophy was a sequel of acute ulceration of the cornea which evolved to panophthalmia. Several investigators in Uruguay have also reported cases of trypanosomiasis with associated keratitis, dacryocystitis and dacryoadenitis.

The extensive literature of Chagas on the subject is conclusive on the trypanosomal origin of the corneal sequelae. However, it is interesting to inquire whether these sequelae are caused by the Trypanosoma itself in the cornea or by the toxins of the organism.

Drs. Salvador Mazza and Cecilio Romaña, Argentina, recently reported the results of their research on trypanosomiasis, carried on in

some rural districts of the provinces of Santa Fe and Mendoza. They pointed out the significance of conjunctivitis and unilateral palpebral edema, which appear in the course of the febrile period of trypanosomiasis, in the early clinical diagnosis of the disease. This type of edema is elastic, does not pit on pressure and entirely disappears when the local inflammation of the acute period has subsided. The presence of the aforementioned ocular diseases in patients with enlargement of the liver and, sometimes, of the spleen indicates the presence of Trypanosoma in the blood of the patients.

The report of the Argentineans make it evident that American trypanosomias exists in various rural sections of Argentina, especially in the so-called Chacos Austral and Santafecino, and that in almost all cases the disease may be recognized by general symptoms and local signs of certain organic trypanosomal reactions.

Unilateral trypanosomal conjunctivitis, as described by Romaña, is an early symptom of diagnostic value. Emanuel Dias and E. Chagas named it "Romaña's sign." It is mainly constituted by unilateral inflammation of the eye caused by conjunctivitis and palpebral edema which develop in the presence of a reaction of the cervical ganglions of the same side. Romaña described the following features of the ocular disease: (1) sudden onset of palpebral inflammation and conjunctivitis in only one eye; (2) appearance of painless elastic edema, which gives a characteristic red-violet color to the eyelid; (3) hyperemia and edema of the conjunctiva, which sometimes progress to chemosis; (4) progression of edema to nearby regions of the face and body on the same side as the involved eye and sometimes also on the opposite side; (5) lack of clinical signs in the cornea and in the inner structures of the eye; (6) scanty conjunctival secretion; (7) satellite glandular reaction of the preauricular, parotid or submaxillary glands of the same side; (8) greater enlargement of one of the glands than of the others, and (9) slow regression of inflammation of the involved eye or sometimes persistence of the inflammation.

Emanuel Dias, of Bello Horizonte, Brazil, recently published an article in *A Folha Medica* in which he stated that this ocular disease is important in the clinical diagnosis of American trypanosomiasis, especially if it develops with all the characteristic symptoms. However, in relation to the characteristic symptoms of the ocular disease, as described by Romaña, it is advisable to point out that Chagas in his cases frequently observed corneal lesions.

Trypanosomal unilateral palpebral edema and the associated conjunctivitis are conditions of both clinical diagnostic value and biologic importance. The frequent clinical occurrence of the ocular disease in trypanosomiasis seems to indicate that the ocular conjunctiva is the most frequent route of infection, although not the only one. Lamus and

other insects bite the face and eliminate on it their excreta containing certain infectious forms of the parasitic protozoa. The parasitic forms penetrate the ocular conjunctiva, enter the eye and cause infection by the so-called contaminating form of transmission. This conception is in accord with the theory that the parasitic protozoon completes its development in the intestine of Lamus, in which the infectious elements of the protozoon for man and other mammals are formed. This explanation is generally accepted, especially as a result of the experiments on the subject reported by Brumpt and Dias. According to Dias, as soon as the parasitic protozoon reaches the tissues it thrives, by preference, within reticuloendothelial cells, from which it passes to the various organs of the body by way of the blood. By an identical mechanism, the reaction of the lymph nodes to local contamination occurs simultaneously with the inflammation of the palpebral tissues and ocular conjunctiva which mark the onset of the disease. The reports of the Argentinean investigators, as well as those of Evandro Chagas, Brynot and Dias of Brazil, confirm the aforementioned interpretation of the pathogenic mechanism of Romaña's sign.

In the cases reported by Carlos Chagas the ocular phenomena were bilateral, whereas in those reported by Romaña they were unilateral. The frequency of unilaterality of the symptoms attracted the attention of Romaña to such an extent that he considered unilaterality as a factor of value in the diagnosis of the disease.

It remains necessary to explain why the infection produced the ocular disease bilaterally in Chagas' cases and unilaterally in 1 of Romaña's. In 1936 I wrote for the first time about the significance of this difference in relation to the pathogenesis of the disease. One paragraph of the article read as follows:

> To explain why the early ocular disease of American trypanosomiasis was bilateral in the cases reported by Chagas and unilateral in those reported by Romaña it seems advisable to think, as a hypothesis, that the mechanism of transmission of the infection was different in the cases reported by the former than in those reported by the latter. In the cases reported by Chagas, the infection was transmitted by the bite of the blood sucking bug on the skin near the eyes (infection from inoculation) rather than by contagion with the infectious parasitic forms. This pathogenic mechanism of the infection is a plausible reason for the occurrence of a bilateral primary inflammatory reaction in association with general phenomena which are more acute than those which appear in unilateral ocular disease. The hypothesis deserves consideration because of the fact that the transmitting insect (Lamus magistus) leaves, by night, the crevices of the cabins in which it lives and bites the people on the face while they are asleep. (The preference of these bugs for biting the face is the reason they are colloquially called "barbers.") The bugs of the Lamus genus are voracious and they exist in great abundance in the State of Minas, especially in the territories in which Chagas carried on his researches. This circumstance seems to justify the frequency of inoculated infection in the cases reported by Chagas. The unilaterality of

trypanosomal edema and conjunctivitis, with the occurrence of satellite ganglionic reaction as reported by Romaña, seems to indicate that the ocular disease in his cases was due to inoculation from entrance of the infectious parasitic forms through the mucosa of the ocular conjunctiva, especially through the conjunctival cul-de-sac where the constant humidity, softness and arrangement of the mucosa in folds constitute favorable conditions for inoculation. Unilaterality of the ocular disease seems to be significant for the pathogenesis of the disease, especially because of the fact that the inflammatory reactions of the unilateral form are of a different aspect from those reported by Chagas in which conjunctivitis, palpebral edema and enlargement of the cervical ganglions were bilateral.

A plausible interpretation of the difference between the typical unilateral inflammatory reaction of the conjunctiva and lids reported by Argentinean investigators and the ocular disease reported by Chagas is that trypanosomal infection occurs by different pathogenic mechanisms in the unilateral and the bilateral form. However, of pathogenic significance may be the report by Chagas on the frequency of palpebral and conjunctival inflammation and corneal lesions in his cases and the photographs of his patients, including some with unilateral palpebral edema, which show the similarity of the trypanosomal ocular disease described by Chagas and that described by Romaña.

When I wrote the aforementioned hypothesis of a different mechanism of infection as the cause of the differences of the trypanosomal ocular lesions found by Brazilian and by Argentinean investigators, the predominant opinion about the pathogenic mechanism of the infection was that it was transmitted either by the bite of the infected insect or by inoculation by metacyclic forms of the parasitic protozoon through the excoriations caused by the insects. The research which has been carried on during the last few years, especially in 1939, limits the pathogenic mechanism of American trypanosomiasis in man to contamination by metacyclic forms of the parasitic protozoon. According to the recently published reports of Karl Denecke and Ernest von Haller, American trypanosomiasis in man occurs only as a result of the entrance of metacyclic forms of Trypanosoma into the body. In accordance with this statement, some authors admitted the possibility of transmission of the infection through the intestinal mucosa after the ingestion of the excreta of Reduviidae, which are infected with metacyclic trypanosomal forms. The latter can enter the human body also through other mucosae.

Therefore, the results of all these studies testify to the importance of the metacyclic forms of Trypanosoma for the transmission of the disease and prove the role of the ocular conjunctiva as the preferred route for inoculation of Trypanosoma. The latter fact is demonstrated in the frequency of early ocular involvement in trypanosomiasis.

Unilaterality and bilaterality of the trypanosomal ocular disease depend on whether the trypanosomal inoculation occurs in one eye or simultaneously in the two eyes. The large number of clinical reports

from Brazil, Argentina and Uruguay of cases of either unilateral or bilateral ocular disease clearly indicate that the ocular mucosa is the port of entry of the metacyclic forms of Trypanosoma and that the ocular disease, which is a characteristic of trypanosomiasis, is purely a local reaction which marks the onset of the infection either in one eye or simultaneously in the two eyes.

DISCUSSION

DR. CHARLES A. BAHN, New Orleans: Chagas' disease has been found in field mice and other rodents in the southwestern part of the United States. The greatest number of instances has been reported in southern California, below San Diego, and as far west as Limestone County, Texas. The infection is carried by the assassin bug, or similar insects, which have also been found in these areas. Experimentally, these insects will produce the disease in animals.

To date, no cases of human infection have been reported in the United States, but ophthalmologists and internists in the Southern states should realize that sooner or later human infections will also occur in this country and will constitute a more or less serious menace to health.

There having been no human cases of Chagas' disease reported in the United States, the literature is obviously limited. I can therefore add but little to the excellent contribution of the distinguished colleague from South America who has brought to attention a subject which will probably be of practical importance at some future time in the United States.

DETACHMENT OF THE PARS CILIARIS RETINAE

A CONTRIBUTION TO THE DIAGNOSIS OF MALIGNANT INTRAOCULAR TUMORS

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Recognition of the malignant intraocular tumor in the earliest possible stage of its growth is of obvious importance. Diagnosis by ophthalmoscopy is not difficult in the initial stage, before the development of subretinal transudation and retinal detachment. Such an extremely early stage is practically never seen, except in some rare instances in which the tumor is near enough to the macula to create a serious disturbance of the central vision.

Once transudation and retinal detachment have occurred, and especially if the tumor is located in the posterior half of the eyeball, diagnosis becomes extremely difficult and is seldom more than presumptive. Consequently, the addition of any pathognomonic feature to the present meager knowledge of this clinical picture, even though it is limited to half of the cases, should be of distinct value.

The present paper reports such a feature, viz., detachment of the pars ciliaris retinae, which I observed in 2 patients in the first stage of malignant melanoma of the choroid. The affected eye was enucleated in each case, and after serial sections had been cut, histologic studies were made with special reference to this new condition. It has been more than ten years since the first observation was made, but publication has been withheld until now, for the purpose of continuing the investigation, making use of additional material, especially histologic, which has become available. The results constitute the most important feature of this report.

REPORT OF CASES

CASE 1.—M. K., a woman aged 47, entered the Rush Medical College ophthalmic clinic four days after the onset of an attack of pain and redness of the right eye, the vision of which had gradually failed over a period of two years until it was reduced to light perception.

Clinical examination of the affected eye revealed a marked complete mixed injection of the bulb, in the upper half of which the anterior ciliary vessels were especially dilated and tortuous. The anterior chamber was more shallow in the

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upper than in the lower portion, which was normal, and there was a well marked aqueous flare of the slit lamp beam. Most of the temporal half of the retina was detached, with many folds; the fundus reflex was normal in the lower nasal quadrant. A brownish mass of solid appearance projected from above downward, behind the lens. The (tactile) tension was not elevated.

After the lapse of one week the lower nasal quadrant of the retina was also detached, and the detachment continued forward as an avascular translucent membrane of extreme delicacy, making contact with the posterior surface of the lens (fig. 1). The extraordinary thinness of this membrane was demonstrated

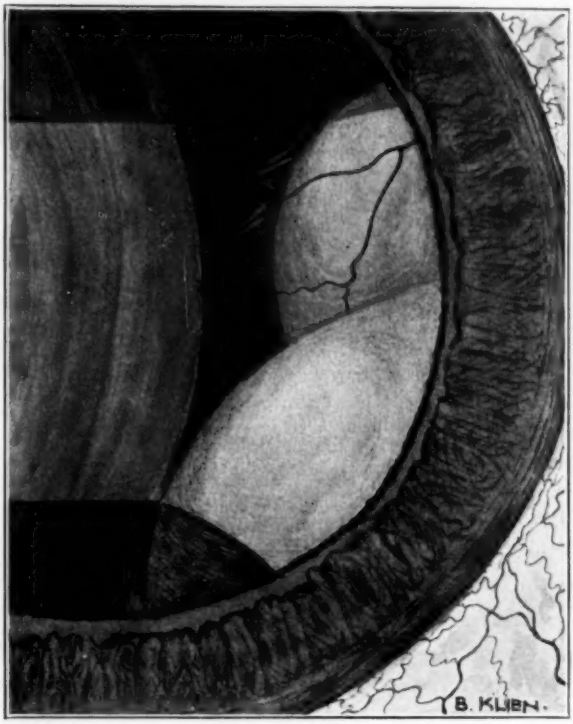

Fig. 1 (case 1).—Clinical view. Note the fine wrinkles.

by the presence of the finest parallel wrinkles rendered visible by the reflected light of the slit lamp. The anterior portions of this even, domelike elevation were regarded as consisting of detached unpigmented ciliary epithelium.

The diagnosis of malignant melanoma of the choroid was made, and three weeks after the first examination the eye was enucleated. At this time there was a slight deformity of the lens at the site of its contact with the detached ciliary epithelium.

Study of the vertical histologic sections showed that the maximal thickness of the tumor, a malignant melanoma of the choroid, was in the superior equatorial region, from which zone it infiltrated the adjoining choroid and the upper

half of the ciliary body. The retina was completely detached, and the inferior and nasal portions, lying within the upper half of the bulb, were continuous anteriorly with the detached unpigmented ciliary epithelium, which, together with the peripheral portions of the retina, was pressed against the lens (fig. 2). The posterior surface of the lens was indented by it as though considerable continuous pressure had existed. The subretinal space was filled with a homogeneous coagulum. Thus the clinical diagnosis of a visible detachment of the pars ciliaris retinae was verified histologically.

CASE 2.—L. McL., a Negress aged 47, entered the ophthalmic clinic of the Cook County Hospital because of loss of vision of the left eye, which had first been noted three months earlier. There had never been any pain or inflamma-

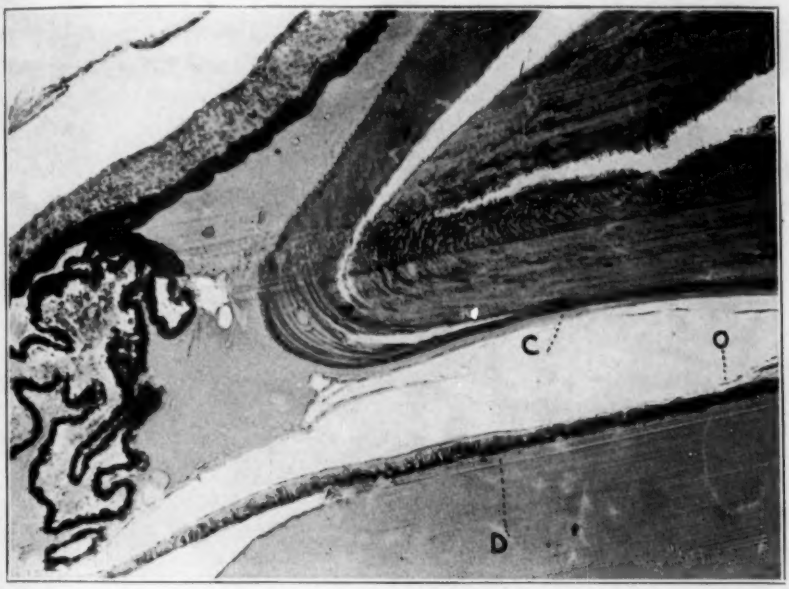

Fig. 2 (case 1).—Histologic view. *C* indicates indentation of lens; *O*, ora serrata; *D*, detached pars ciliaris retinae.

tion; the vision of the left eye was reduced to bare light perception with faulty projections. Clinical examination of the affected eye revealed marked tortuosity of the anterior ciliary vessels, a very shallow anterior chamber and a fixed, dilated pupil. The cornea and the lens were clear. There was a bullous detachment of the temporal half of the retina, and just behind the lens, in the inferior nasal quadrant, a well defined vascularized mass could be seen with oblique illumination. Just above this mass the slit lamp showed a delicate gray smoothly rounded avascular membrane, bulging forward and toward the midline as far as the vertical meridian (fig. 3*A*). A dark ridge crossing the superior nasal margin of this elevation was regarded as either the ora serrata or, more probably, in view of the homogeneous smoothness and the thinness of the membrane below it, a demarcation line between the detached and the undetached ciliary epithelium.

Study of the vertical histologic sections (fig. 3 *B*) revealed an extensive detachment of the unpigmented ciliary epithelium, corresponding to the clinically described gray elevation. The tumor, a malignant melanoma of the ciliary body,

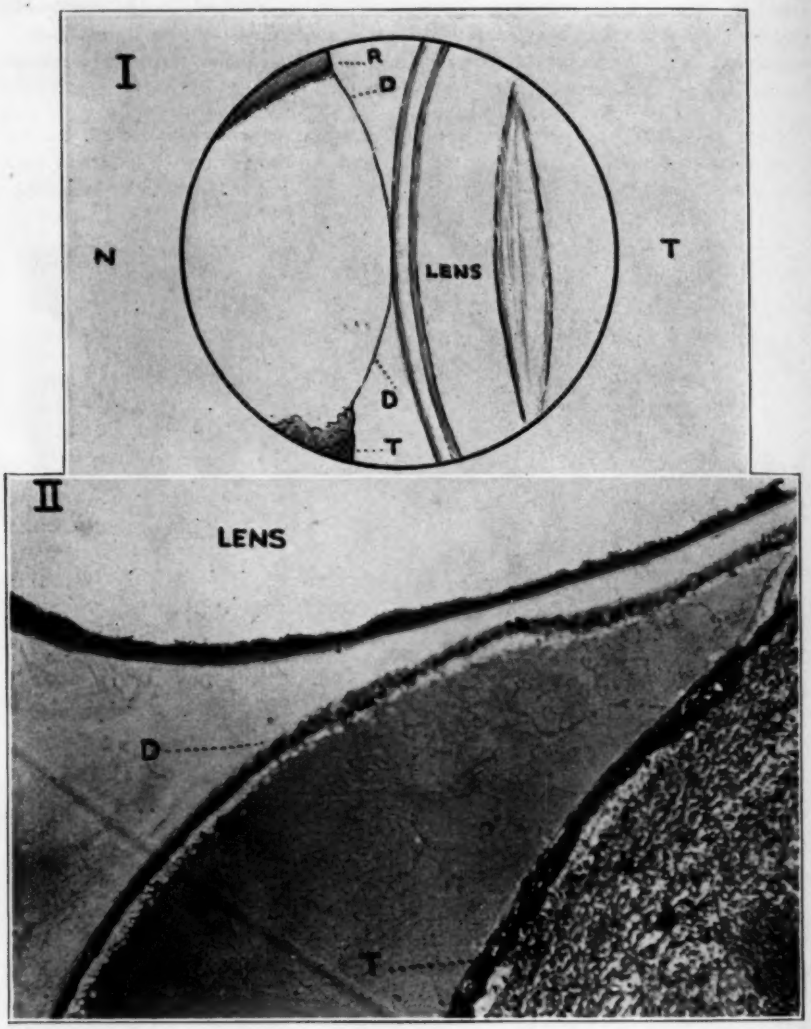

Fig. 3 (case 2).—I, diagram of clinical view. *N* indicates the nasal side; *T*, the temporal side. II, histologic view. *R* indicates dark ridge; *D*, detached pars ciliaris retinae; *T*, tumor.

had its maximal elevation in the inferior nasal sector and extended upward into those parts of the ciliary body where the unpigmented ciliary epithelium was detached. Transudate, hemorrhage and a number of tumor precipitates were found throughout the subretinal space.

DIFFERENTIAL DIAGNOSIS

The clinical differentiation between a detached retina and an extensively detached ciliary epithelium can be made by observation of the following features of the pars ciliaris retinae: 1. It is a completely avascular membrane. 2. The convexity of its bulging surface is perfectly even. 3. It has an extremely delicate thinness, which is demonstrated in places where slight traction in one direction produces numerous fine parallel wrinkles without disturbing the grossly even curvature.

Histologically, the cells of the detached epithelium are of normal shape and size, thus differentiating this primary detachment, on the one hand, from a secondary detachment due to traction by shrinking membranes in the vitreous or posterior chamber, which leads to considerable flattening and elongation of these cells, or, on the other hand, from membranes resulting from proliferation of these cells, which may be very extensive, but which does not produce typical and normal cells.

OBSERVATIONS

Several groups of eyes were studied histologically in search of the combination of detachment of the pars ciliaris and of the pars optica retinae.

Group 1: Fourteen eyes with malignant tumors of the posterior segment, excluding those in the third stage, i. e., with extraocular extension, and those in which surgical procedures had preceded the enucleation. Detachment of the unpigmented ciliary epithelium was found in 8 of the 14 eyes, i. e. in 57 per cent (table 1). In some of these the detachment was so extensive that it might have been possible to see it clinically had a search for it been made (I did not see these eyes clinically). Figure 4 illustrates such a detachment in retinoblastoma. Of these 8 eyes, the tumor was in the first stage in 5, while in the other 3 secondary glaucoma had already developed.

In every instance of retinoblastoma or malignant melanoma of the choroid in which there was a detachment of the pars ciliaris retinae, the location of the tumor was no farther forward than the equator. The location of the detachment of the pars ciliaris retinae was unrelated to the location of the tumor. The subretinal space was filled in some instances with transudate, while in others hemorrhages and tumor precipitates were combined with the otherwise homogeneous substance.

There was also the question as to what other types of retinal detachment may occur in combination with detachment of the unpigmented ciliary epithelium. For the study of this question, the available material,

all of which was histologic, with the exception noted in group 2, was divided into the following additional groups:

Group 2: Three eyes with idiopathic retinal detachment. In addition to these histologically studied eyes, there were 6 eyes which were studied clinically in an effort to find a detachment of the ciliary epithelium.

Group 3: Two eyes with Coats's disease, or so-called external exudative retinitis.

TABLE 1.—*Malignant Intraocular Tumors of the Posterior Segment*

Patient	Age, Years	Type of Tumor	Stage	Location	Detachment of Pars Ciliaris Retinae	
M. K.	3	Retinoblastoma	I	Posterior to equator	+	(by transdudate)
J. H.	3	Retinoblastoma	II	Posterior to equator	++	(by transudate and tumor cells)
L. McL.	47	Melanoma of the ciliary body	I	From equator forward	++	(by transudate, tumor cells and hemorrhages clinically visible)
G. L. T.	36	Metastatic cancer of the choroid	I	Posterior to equator	—	
J. P.	52	Melanoma of the choroid	I	From equator backward	+	(by transudate)
J. K.	56	Melanoma of the choroid	II	At equator	+	(by transudate)
Mrs. P.	38	Melanoma of the choroid	I	Posterior to equator	—	
35-4	?	Melanoma of the choroid	II	From equator forward	—	
36-4	?	Melanoma of the choroid	I	From equator backward	—	
D. C.	6	Dictyoma retinae	I	Filling entire cavum oculi	—	
M. K.	42	Melanoma of the choroid	I	At equator	++	(by transduate; clinically visible)
C. P.	6	Retinoblastoma	I	Posterior to equator	+	(by transudate and tumor cells)
38-12	?	Melanoma of the choroid	II	At equator	+	(by transudate)
A. E.	41	Melanoma of the choroid	I	From equator forward	—	

Group 4: Three eyes with perforated corneal ulcers and retinal detachment.

Group 5: Ten eyes with traumatic retinal detachment due to injuries, both perforating and nonperforating.

In groups 4 and 5 only eyes with conditions of short duration were considered, in which shrinking processes in either the vitreous or the posterior chamber were absent, as the condition under discussion is a primary detachment of the unpigmented ciliary epithelium and not a secondary detachment by traction, as is so often observed in degenerating eyes.

TABLE 2.—*Detachment of Pars Ciliaris Retinae in Patients with Retinal Detachment*

Patient	Age, Years	Type of Retinal Detachment	Observation	Detachment of Pars Ciliaris Retinae
J. S.	40	Idiopathic; tear in temporal half; left eye	Clinical	—
M. C.	42	Idiopathic; no tear visible; right eye	Clinical	—
A. C.	36	Idiopathic; tear in temporal half; right eye	Clinical	—
A. C.	36	Idiopathic; multiple nasal tears; right eye	Clinical	—
C. S.	58	Idiopathic; tears in upper half; right eye	Clinical	—
V. S.	53	Idiopathic; tear in upper half; right eye	Clinical	—
D. C.	32	Idiopathic; retinal disinsertion.....	Histologic	—
J. S.	24	Idiopathic; flap tear.....	Histologic	—
R. S.	49	Idiopathic; myopic eye.....	Histologic	—
A. B. K.	36	Coats's disease	Histologic	—
P. S.	7	Coats's disease	Histologic	—
A. T.	47	Perforating corneal ulcer with retinal detachment	Histologic	+ (by hemorrhage)
P. W.	40	Perforating corneal ulcer with retinal detachment	Histologic	—
V. M.	29	Perforating corneal ulcer with retinal detachment	Histologic	—

TABLE 3.—*Detachment of Pars Ciliaris Retinae in Injured Eyes*

Patient	Age, Years	Type of Injury	Time Between Injury and Removal of Eye	Histologic Features	Detachment of Pars Ciliaris Retinae
R. D.	28	Nonperforating; violent (boxing)	3 mo.	Disinsertion of retina	++ (by hemorrhage)
S. J.	?	Perforating; violent (glass)	3 days	Disinsertion of retina	++ (by hemorrhage and transudate)
E. G.	36	Perforating; violent (steel)	6 days	Disinsertion of retina	+ (by transudate)
E. B.	33	Perforating; violent (stabbing)	2 wk.	Disinsertion of retina	++ (by hemorrhage)
W. S.	?	Perforating (fist)	1 day	Disinsertion	++ (by hemorrhage)
A. G.	8	Perforating (bullet)	2 wk.	Retinal detachment by hemorrhage	—
E. L.	37	Perforating (fall on rock)..	4 wk.	Retinal and choroidal detachment	—
B. W.	65	Perforating (fall on ice)....	4 mo.	Disinsertion of retina	—
R. M.	?	Nonperforating (fist)	12 hr.	Retinal disinsertion and rupture of choroid	—
R. P.	34	Perforating (stabbing)	2 wk.	Retinal detachment	—

Detachment of the ciliary epithelium was not demonstrable in the 6 eyes with idiopathic retinal detachment examined clinically, 5 of which had typical single or multiple retinal tears. None was found in the 3 eyes of this group studied histologically, of which 1 had a retinal disinsertion, 1 had a typical flap tear and the third, a known myopic eye, had already much secondary proliferation of both ciliary epithelial layers but no primary detachment of the pars ciliaris retinae. It was also absent in the 2 eyes with retinal detachment due to Coats's disease (table 2). Of the 3 eyes with perforated corneal ulcer and retinal detachment, the pars ciliaris retinae was detached, by massive hemorrhage, in 1.

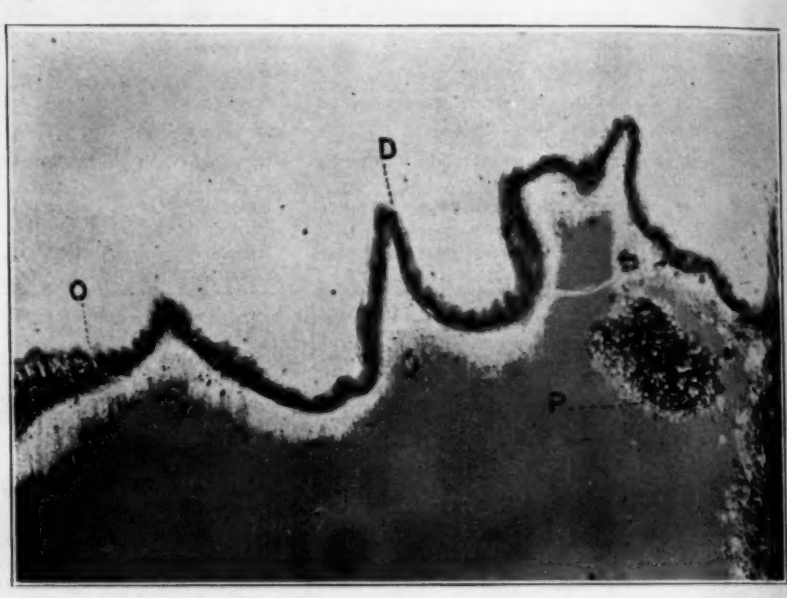

Fig. 4.—Detached pars ciliaris retinae in eye with retinoblastoma. *P* indicates tumor precipitate; *O*, ora serrata; *D*, detached pars ciliaris retinae.

Among the 10 eyes with recent injuries, nonpenetrating in 2 of them, there were 5 eyes, including 1 of the eyes with a nonpenetrating injury, which had an extensive detachment of the unpigmented ciliary epithelium (table 3). These 5 eyes had several features in common. All had an extensive retinal disinsertion at the ora, and in all of them the condition was the result of a violent injury, either pure contusion or contusion combined with perforation. In 4 of these eyes, the detachment of the ciliary epithelium was extensive, and there was a massive hemorrhage in the subretinal space. In 1 eye only, this detachment was not very extensive and only transudate filled the space beneath it. Such extensive traumatic detachments of the unpigmented ciliary epithelium are shown in figure 5.

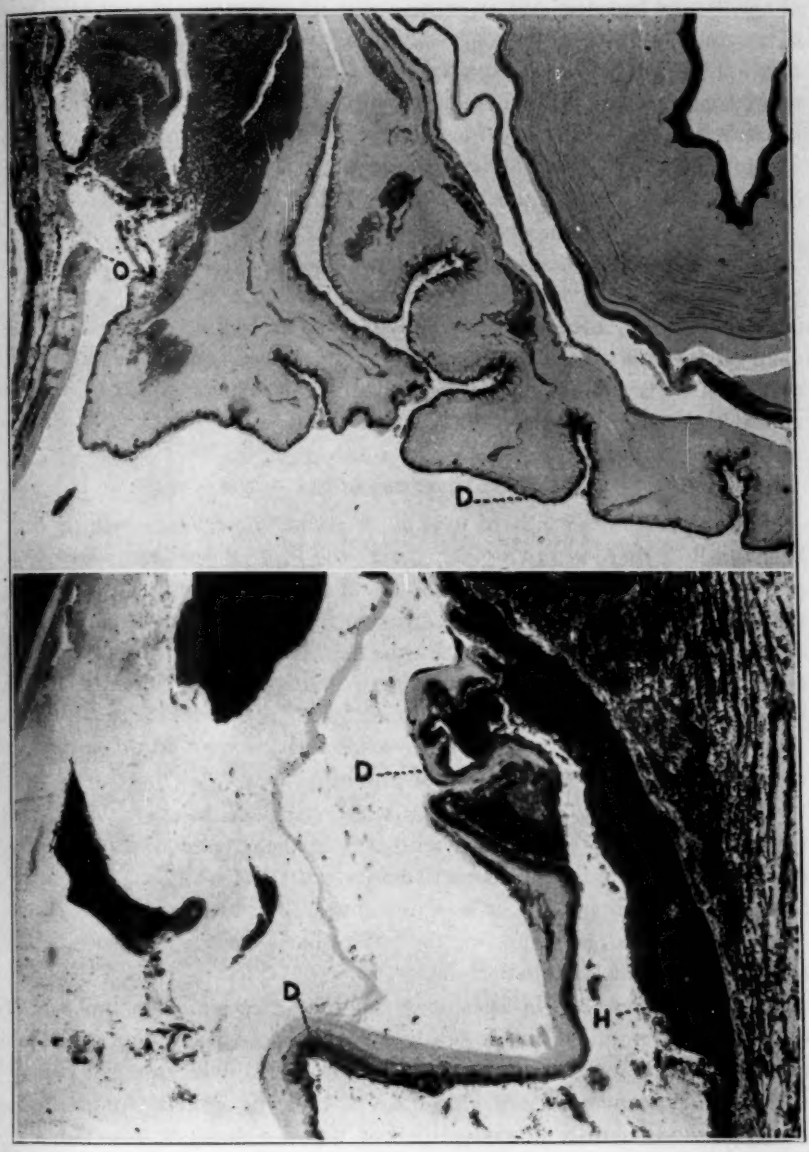

Fig. 5.—Traumatic detachment of pars ciliaris retinae. *H* indicates hemorrhage; *D*, detached pars ciliaris retinae; *O*, ora serrata.

From these histologic observations in the cases of detachment of the ciliary epithelium, including the deformity of the lens, which was observed clinically and histologically in case 1, a single feature common to all these cases stands out as the primary factor in the pathogenesis of this condition. This feature is postulated to be an increased pressure in the subretinal space of either hemorrhagic origin, as in most of the cases of injuries and in 1 case of perforated corneal ulcers, or transudative, often in combination with hemorrhage, as in the cases of malignant tumors of the posterior segment.

Retinal detachment in which there is merely a reduction of the intraocular pressure has not been accompanied by a detachment of the pars ciliaris retinae in any of the cases studied. The added factor of increased subretinal pressure is necessary to lead to a peeling off of the ciliary epithelium. On the other hand, increased subretinal pressure alone may lead to it without preceding reduction of tension, as study of the eyes with intraocular tumors has proved.

SUMMARY AND CONCLUSIONS

Of the several groups of eyes with retinal detachment which have been studied, there are two groups, viz., the injured ones and those with perforated corneal ulcers, in which retinal detachment and detachment of the ciliary epithelium, when present, are irrelevant from the standpoint of the differential diagnosis of intraocular tumor. In those groups of eyes the area accessible to intraocular examination is frequently limited by opacities of the media and other conditions. When detachments can be seen, their relation to the perforating scars and other conditions is usually sufficient to exclude the question of tumor.

In the remaining groups of eyes with retinal detachment, viz., those with the idiopathic type, those with retinal detachment due to Coats's disease and those with intraocular tumors, for all of which types ophthalmoscopy is usually feasible, it is significant that the combination of detachment of the pars optica and of the pars ciliaris retinae has been found only in the ones with tumors.

While the number of eyes with idiopathic retinal detachment and Coats's disease studied histologically is naturally very small and ophthalmoscopy of the eyes with clinical idiopathic retinal detachment was done without the contact lens, it would seem that the clinical finding of a detached unpigmented ciliary epithelium points almost with certainty to a condition producing an increased subretinal pressure, and suspicion of a tumor in such an eye should be entertained.

It is a well known fact that even a small tumor may cause an extensive retinal detachment and thus, by its small size or posterior location, may

make the results of transillumination doubtful. The additional finding of a detached pars ciliaris retinae in such eyes should add more certainty to the clinical diagnosis of tumor. Its special value in cases of tumor located too far back to permit decisive observations on transillumination is shown by the fact that its occurrence with tumors was limited, with 2 exceptions, to tumors which were not located anterior to the equator. The peripheral portions of the detached retina in these eyes should be systematically examined by ophthalmoscopy, if possible with the aid of a contact lens, in a careful search for detachment of the unpigmented ciliary epithelium.

It is hoped that this report of a new diagnostic sign will stimulate ophthalmologists to look for it in the ophthalmoscopic examination of all eyes suspected of harboring a malignant tumor, as well as in the histologic study of the enucleated eyes. Should the investigation of hundreds of cases of intraocular tumor demonstrate that the incidence of detachment of the ciliary epithelium is comparable to, or even greater than, that in this small series, then its importance as a diagnostic sign of intraocular tumor will become firmly established.

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BOECK'S SARCOID WITH OCULAR LOCALIZATION

SURVEY OF THE LITERATURE AND REPORT OF A CASE

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Boeck's sarcoid is a chronic relatively benign disorder of unknown cause with particular predilection for the lymphatic tissue or the reticuloendothelial system. It has been described in the literature under numerous titles: Boeck's disease, Besnier-Boeck disease, Besnier-Boeck-Schaumann disease, Schaumann's disease, benign lymphogranulomatosis, sarcoidosis, noncaseating tuberculosis, pseudotuberculosis and paratuberculosis. The term sarcoid was adopted by Boeck [1] in 1899 for lesions simulating sarcomas and leukemic conditions of the skin. He believed the condition to be one only of the skin. Later he recognized his mistake in the term and changed it to multiple miliary lupoid because of the granulomatous structure, like that seen in tuberculosis and leprosy. In 1906 Darier and Roussy described another type of this disease, in which the lesions were situated deep. Ten years before Boeck's article, in 1889, Besnier [2] described a type of lupus which he called lupus pernio or chilblain lupio, but this name had already been used by Hutchinson [3] for what proved to be lupus erythematosus. Besnier's cases were later proved by Tenneson to be cases of lupus vulgaris, which is tuberculosis.

The modern concept of a widespread disease syndrome capable of involving any organ of the body with or without cutaneous lesions was propounded by Schaumann [4] in 1914, Kuznitzky and Bittorf [5] in 1915,

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Read before the Section of Ophthalmology of the New York Academy of Medicine, Dec. 16, 1940.

1. Boeck, C.: Multiple Benign Sarcoid of Skin, J. Cutan. & Genito-Urin. Dis. **17**:543, 1899.

2. Besnier, E.: Lupus pernio de la face, synovites fungeuses (scrofulo-tuberculeuses) symmétriques des extremités supérieures, Ann. de dermat. et syph. **10**:333, 1889.

3. Hutchinson, cited by Hunter, F. T.: Hutchinson-Boeck's Disease (Generalized "Sarcoidosis"): Historical Note and Report of a Case with Apparent Cure, New England J. Med. **214**:346, 1936.

4 Schaumann, J.: Sur le lupus pernio (Mémoire présenté en novembre (1914) à la Société française de dermatologie pour la prix Zambaco): Etude sur le lupus pernio et ses rapports avec les sarcoïdes et la tuberculose, Ann. de dermat. et syph. **6**:357, 1916.

5. Kuznitzky, E., and Bittorf, A.: Boecksches Sarkoid mit Beteiligung innerer Organe, München. med. Wchnschr. **62**:1349, 1915.

Kissmeyer [6] in 1932 and Pautrier [7] in 1934. It has been further amplified within recent years by numerous authors, including Salvesen,[8] Schaumann,[9] Tillgren,[10] Longcope and Pierson,[11] Pinner,[12] Snapper and Pompen,[13] Ustvedt,[14] Scott,[15] Harrell,[16] Reisner,[17] Lambie [18] and Pautrier.[19]

The disease affects young adults of either sex. Most of the examples reported have been in persons of the white race. Three series of cases in this country have been reported in which the patients were almost entirely Negroes. The increasing number of reported cases indicates that the disease is far from a rarity. The general health of a patient with this disease is relatively good, and clinical symptoms are few or absent. There is usually no fever, although there may be febrile periods lasting for weeks or months. The condition is discovered through

6. Kissmeyer, A.: La maladie de Boeck, sarcoïdes cutanées bénignes multiples, Copenhagen, Levin & Munksgaard, 1932.

7. Pautrier, L. M.: Les lésions granuliques pulmonaires de la maladie de Besnier-Boeck, difficultés d'interprétation des images radiologiques micronodulaires, Bull. et mém. Soc. méd. d. hôp. de Paris **50**:1409, 1934; Cinq cas de maladie de Besnier-Boeck, lymphogranulomatose bénigne de Jorgen Schaumann (Sarcoïdes dermiques disséminées à gros nodules avec lésions ganglionnaires et pulmonaires), Bull. Soc. franç. de dermat. et syph. **41**:1284, 1934.

8. Salvesen, H. A.: The Sarcoid of Boeck: Disease of Importance to Internal Medicine, Acta med. Scandinav. **86**:127, 1935.

9. Schaumann, J.: Lymphogranulomatosis Benigna in the Light of Prolonged Clinical Observations and Autopsy Findings, Brit. J. Dermat. **48**:399, 1936.

10. Tillgren, J.: Schaumann's Disease (Lymphogranulomatosis Benigna), Acta med. Scandinav. **93**:189, 1937.

11. Longcope, W. T., and Pierson, J. W.: Boeck's Sarcoid (Sarcoidosis), Bull. Johns Hopkins Hosp. **60**:223, 1937.

12. Pinner, M.: Non-Caseating Tuberculosis: An Analysis of the Literature, Am. Rev. Tuberc. **37**:690, 1938.

13. Snapper, I., and Pompen, A. W.: Pseudo-Tuberculosis in Man: I. Besnier-Boeck's Disease, Haarlem, Holland, de Erven F. Bohn, 1938.

14. Ustvedt, H. J.: Nosography and Diagnosis of Boeck's Sarcoid, Nord. med. (Norsk mag. f. lægevidensk.) **2**:1677, 1939.

15. Scott, R. B.: The Sarcoidosis of Boeck, Brit. M. J. **2**:777, 1938.

16. Harrell, G. T.: Generalized Sarcoidosis of Boeck: A Clinical Review of Eleven Cases, with Studies of the Blood and the Etiologic Factors, Arch. Int. Med. **65**:1003 (May) 1940.

17. Reisner, D.: Boeck's Sarcoid and Systemic Sarcoidosis, Nat. Tuberc. A. Tr. **35**:107, 1939.

18. Lambie, C. G.: Besnier-Boeck's Disease or Benign Lymphogranulomatosis of Schaumann (the Besnier-Boeck-Schaumann Syndrome), M. J. Australia **1**: 815, 1940.

19. Pautrier, L. M.: La maladie de Besnier-Boeck-Schaumann: Ses manifestations cutanées, ganglionnaires, pulmonaires, osseuses, oculaires, glandulaires, viscérales, nasales, nerveuses, Paris, Masson et Cie, 1940.

cutaneous or ocular manifestations or in the course of roentgenologic studies of the chest or bones. The lymph nodes and lungs are almost invariably affected, usually in association with various combinations of other organs, of which lesions of the skin and bones are the most common. Characteristic are the roentgenologic findings in the chest and in the bones of the hands and feet. The lungs [20] present a reticular infiltration resembling miliary tuberculosis, most marked near the hili and the medial part of the lower lobes, with increased hilar shadow due to hilar lymphadenopathy. The bones present either punched-out cystlike areas toward the ends of the shafts of the phalanges (Jüngling's disease,[21] ostitis multiplex tuberculosa cystica) or a lattice-like appearance with more diffuse involvement. The two main types of cutaneous lesions [22] associated with the disease, superficial (Boeck) and deep (Darier-Roussy), have a predilection for the face, the external surfaces of the arms, the shoulders and the trunk, but they may be found in other areas. A negative reaction to a tuberculin test has been regarded as important. Some patients have positive Wassermann reactions, which are considered false positive reactions. The course of the disease is protracted and characterized by a remarkable tendency toward healing. Death does not result from lesions of the disease except in rare instances.

Boeck's sarcoid presents a constant histologic picture in every involved structure. It is usually described as a granuloma consisting of nodules formed by collections of epithelioid cells mixed with a varying number of lymphocytes and occasional giant cells of the Langhans type. This lesion is distinguished histologically from the usual lesion of tuberculosis in that caseation is absent and acid-fast bacilli cannot be demonstrated. The similarity to lesions found in such diseases as tuberculosis, syphilis, leprosy, brucellosis, yaws, leishmaniasis and lymphogranuloma venereum has been pointed out by many investigators. Healing occurs by fibrosis and hyaline transformation or by restitution to normal. Conclusive diagnosis can be made only by biopsy.

The cause is undetermined. A lively controversy exists in the literature as to the relation of the condition to tuberculosis. Many authors, and Schaumann in particular, have stated the belief that it is an atypical phase of tuberculosis and have explained the negative reaction to tuberculin on the basis of a relative positive anergy resulting in a high

20. Meisels, E.: Course of Besnier-Boeck's Disease of Lungs in Serial Roentgenograms, Am. J. Roentgenol. **44**:564, 1940.

21. Jüngling, O.: Ostitis tuberculosa multiplex cystoides (eine eigenartige Form von Knochentuberculose), Fortschr. a. d. Geb. d. Röntgenstrahlen **27**:375, 1919.

22. Andrews, G. C.: Diseases of the Skin, ed. 2, Philadelphia, W. B. Saunders Company, 1938, p. 376.

resistance due to the elaboration of substances capable of neutralizing tuberculin. Some investigators have demonstrated tubercle bacilli in cutaneous lesions; some have reported frank tuberculosis noted during clinical observation or at necropsy, and some claim to have produced tuberculosis by animal inoculation of material from lesions. Most authors, however, have been unable to confirm the aforementioned observations after painstaking investigation, and they have suggested that either a specific virus is the causative agent or the condition represents a nonspecific reaction of the body tissues to a variety of agents.

No specific therapy is known. The general measures advocated for tuberculosis are usually recommended, such as a high calory, high vitamin diet, rest and sunshine. Numerous methods of treatment have

Main Lesions of the Eye and Adnexa in Patients with Boeck's Sarcoid

Author	Patients with Boeck's Sarcoid	Patients with Ocular Lesions	Type of Involvement								
			Lids	Lacrimal Glands	Conjunctiva	Uveitis			Phthisis Bulbi		
						Total	Bilateral	Unilateral	Total	Bilateral	Unilateral
Salvesen [3]	4	2	..	..	1	1	1	..	..	..	..
Schaumann [9]	4	1	..	..	..	1	..	1	1	1	..
Longcope and Pierson [11]	8	3	2	3	..	1	1	..	1	1	..
Snapper and Pompen [13]	13	6	..	..	2	5	4	1	1	1	..
Scott [15]	8	3	..	1	..	2	1	1	1	1	..
Horton, Lincoln and Pinner [65]	4	2	..	..	..	2	2	..	1	1	..
Leder [35]	13	4	..	..	2	2	2	..	..	..	..
Ustvedt [14]	12	7	..	2	1	5	5	..	1	..	1
Harrell [16]	11	7	5	1	..	3	2	1	1	1	..
Reisner [31]	23	8	..	2	..	6	5	1	3	1	2
Total	100	43	7	9	6	28	23	5	10	7	3

been tried, many with beneficial results, including arsenic in the form of solution of potassium arsenite U. S. P. or arsphenamine, roentgen and radium irradiation of the skin and pulmonary lesions, ultraviolet ray therapy, tuberculin therapy, injections of gold sodium thiosulfate and injections of chaulmoogra oil. Owing to the benign character and irregular course of the disease, it is difficult to assess the value of these types of therapy.

TYPES OF INVOLVEMENT IN BOECK'S SARCOID

Snapper and Pompen [13] stated that the eye is one of the favorite sites of the disease and that many patients first consult ophthalmologists. Some idea of the incidence and of the main types of ocular involvement may be gleaned from the table, which is a survey of a series of cases reported within recent years in the general medical literature.

King [23] reviewed the records of the Massachusetts Eye and Ear Infirmary and, in several hundred cases of negative reactions to tuberculin tests and of conditions diagnosed clinically as tuberculous, found 7 cases of Boeck's sarcoid. Six of the patients had uveitis, of whom 5 had bilateral involvement; 3 had associated keratitis, and 2 had parotitis. One patient had an orbital mass which proved to have the typical histologic picture, and later typical manifestations of the disease developed. Walsh [24] cited 6 cases of Boeck's sarcoid presenting examples of lesions on the lids, uveitis, enlargement of the lacrimal glands and involvement of the central nervous system. He further stressed the uveoparotid syndrome as a clinical variant of Boeck's sarcoid.

Lids.—Cutaneous lesions which frequently appear on the face may be present on the lids. Harrell,[16] noting an invasion of the margins of the lids in 5 of 11 cases, emphasized that the margins are seldom implicated in other cutaneous diseases which involve the face. Small painless firm nodules may also be found. These may be the only ocular manifestation or may be associated with other lesions. Holm [25] reported a case in which nodules on the lids presenting the typical histologic picture of sarcoid were present, without any demonstrable systemic pathologic changes. Other cases of involvement of the lid have been reported in ophthalmic literature by Wilmer,[26] Derby and Verhoeff,[27] Lehrfeld,[28] Ernsting,[29] von Bahr [30] and Walsh.[24] In the case of Wilmer there was, in addition, a tumor-like episcleral mass over the internal rectus muscle, which presented a sarcoid structure on microscopic examination.

Lacrimal Glands.—Boeck's sarcoid may be the cause of enlargement of one or both lacrimal glands. Bilateral involvement associated with bilateral enlargement of the salivary glands, forming the disease or syndrome of Mickulicz, has frequently been reported. In the cases reported by Longcope and Pierson,[11] Scott,[15] Ustvedt,[14] Harrell [16] and Reisner [31]

23. King, M. J.: Ocular Lesions of Boeck's Sarcoid, Tr. Am. Ophth. Soc. **37**:422, 1939.

24. Walsh, F. B.: Ocular Importance of Sarcoid: Its Relation to Uveoparotid Fever, Arch. Ophth. **21**:421 (March) 1939.

25. Holm, E.: A Case of Sarcoid of Boeck, Acta ophth. **15**:235, 1937.

26. Wilmer, W. H.: Tubercle-Like Nodules of Episclera and Eyelids: Bilateral, Tr. Am. Ophth. Soc. **31**:59, 1933.

27. Derby, G. S., and Verhoeff, F. H.: Sarcoid of the Eyelid, Arch. Ophth. **46**:312, 1917.

28. Lehrfeld, L.: Sarcoid of the Eyelids, Am. J. Ophth. **10**:255, 1927.

29. Ernsting, H. C.: Boeck's Sarcoid of Eyelid with Co-Existing Darier-Roussy's Sarcoid: Report of Case with Review of Literature, Arch. Ophth. **17**: 493 (March) 1937.

30. von Bahr, G.: Uveoparotitis with Perivasculitis and Other Rare Symptoms: Report of a Case, Acta ophth. **16**:101, 1938.

31. Reisner, D.: Personal communication to the author.

enlargement of the lacrimal gland was noted. Wexler,[32] in 1939, presented a case of bilateral swelling of the lacrimal glands in which microscopic study showed the typical histologic sarcoid infiltration. Walsh [24] reported bilateral swelling of the lacrimal glands in a case of widespread sarcoidosis. Stallard [33] recently described a case of unilateral swelling of the lacrimal gland associated with lymphadenopathy, splenomegaly and mediastinal changes. Excision of the gland proved the sarcoid nature of the enlargement.

Conjunctiva.—Lesions of the conjunctiva, described as early as 1900 by Boeck, are considered of rare occurrence. Blegvad [34] reported them in 3 of 20 cases of Kissmeyer. Snapper and Pompen [13] found conjunctival nodules in 2 of 13 cases, and Leder [35] observed a similar incidence. Pautrier [19] mentioned 4 cases among 14 presented before the Congress of Copenhagen. Conjunctival nodules may occur with or without other ocular lesions. Cases have been reported by Lutz,[36] Schoeppe,[37] Strandberg,[38] Lehrfeld [28] and Igersheimer.[39] Seefelder [40] reported a case in which the conjunctival folds were involved with follicle formation and small lumps in the conjunctiva showed changes corresponding fully to changes in the skin and other organs. He attributed special significance to the finding of calcium concretions in numerous giant cells present in the follicles and stated that such changes have been seen only in tuberculosis. Folk [41] reported a case the interesting feature of which was the occurrence of a conjunctival lesion with the typical histologic picture but without any other apparent manifestation of Boeck's sarcoid. Pautrier [19] presented a composite picture of the clinical appearance of the conjunctival lesions. They may be found in the palpebral conjunctiva, in the bulbar conjunctiva or in the cul-de-sac. They appear

32. Wexler, D.: Sarcoid of Lacrimal Gland, Arch. Ophth. **23**:220 (Jan.) 1940.

33. Stallard, H. B.: Boeck's Sarcoidosis of Lacrimal Gland, Brit. J. Ophth. **24**:451, 1940.

34. Blegvad, O.: Boecks Sarcoid der Conjunctiva, Acta ophth. **9**:180, 1931.

35. Leder, M.: Katamnestische Untersuchungen bei 13 Fällen von Boeckschen Sarkoid, Dermatologica **80**:142, 1939.

36. Lutz, W.: Zur Kenntnis des Boeckschen Miliarlupoids, Arch. f. Dermat. u. Syph. **126**:947, 1919.

37. Schoeppe, H.: Ein Beitrag zur Frage der Augenveränderungen beim Boeckschen Lupoid, Klin. Monatsbl. f. Augenh. **65**:812, 1920.

38. Strandberg, J.: Contribution à la question de la clinique et de la pathogénie de la sarcoïde de Boeck, Acta dermat.-venereol. **2**:253, 1921.

39. Igersheimer, J.: Symmetrische Bindehaut-Geschwulst bei Boeckschen Sarkoid, Klin. Monatsbl. f. Augenh. **74**:518, 1925.

40. Seefelder, R.: Ein weiterer Beitrag zur den Augenveränderungen bei der Boeckschen Krankheit, Arch. f. Augenh. **10**:415, 1937.

41. Folk, M. R.: Boeck's Sarcoid of the Palpebral Conjunctiva, Arch. Ophth. **24**:462 (Sept.) 1940.

as small nodules, sometimes level with and sometimes projecting slightly from the surface of the globe. They are round or oval and vary in size from that of a pinhead to that of a lentil. Lesions may be isolated or confluent and may assume the appearance of a chalazion. The color is gray, yellow-brown or yellow-red, with a waxy aspect. They are firm, painless and movable on the conjunctiva. Sometimes the conjunctiva is injected and the nodule may be slightly tender. There may be slight secretion and also slight symblepharon.

Another possible form of conjunctival involvement is that described as a conjunctivoparotid localization by Thomas [42] and by Pierre and Morax.[43] Thomas reported a case presenting clinically the features of Parinaud's conjunctivitis with unilateral involvement, conjunctival granulations and preauricular adenopathy. The histologic picture of the excised conjunctival lesion and of the gland, which proved to be parotid structure, was consistent with the diagnosis of Boeck's sarcoid. Pierre and Morax reported a similar case, in which they considered the condition clinically somewhat at variance with that observed in cases of Parinaud's disease but agreed on the basis of pathologic evidence that there is a conjunctivoparotid localization of Boeck's sarcoid. In neither of these cases was there any other manifestation of Boeck's sarcoid.

Cornea.—There is little specific reference in the literature to involvement of the cornea. Osterberg [44] stated that corneal involvement is rare but does occur, citing cases reported by Weidman,[45] Plancherel,[46] Schoeppe,[37] Mylius [47] and Nordin.[48] Keratitis, when present, is associated with uveitic inflammation and is almost always overshadowed by the predominant uveal lesion with the accompanying descemetitis. Moreover, an edematous cornea, the result of elevated intraocular tension, may further add to obscure the keratitis. The corneal process tends to affect the lower part of the cornea first and to be interstitial in character. Dense opacification of the cornea may result. However, all grades of

42. Thomas, C.: Conjunctivite de Parinaud et parotidite (relations avec le syndrome de Heerfordt), Bull. Soc. d'opht. de Paris **50**:382, 1938.

43. Pierre, M., and Morax, V.: Un cas de lésion conjunctivale avec adénopathie d'étiologie imprécisée. Ses rapports avec la lymphogranulomatosis bénigne de Besnier-Boeck-Schaumann, Bull. Soc. d'opht. de Paris **50**:436, 1938.

44. Osterberg, G.: Sarcoid of Boeck in Iritis (Iritis Boeck), Nord. med. tidskr. **16**:1125, 1938; Brit. J. Ophth. **23**:145, 1939.

45. Weidman, F. D.: Sarcoid of Boeck and Lichen Scrofulosorum: Arsphenamine Treatment, Arch. Dermat. & Syph. **5**:423 (March) 1922.

46. Plancherel, C.: Beitrag zur Lehre vom Boeckschem Sarkoid, Dermat. Ztschr. **21**:676, 1914.

47. Mylius, K.: Boecksches Sarkoid und Auge, Ztschr. f. Augenh. **65**:71, 1928.

48. Nordin, G.: Morbus Schaumann (Lymphogranulomatosis benigna), Acta dermat.-venereol. **18**:245, 1937.

involvement may occur. Of the 7 patients with Boeck's sarcoid reported on by King,[23] 3 had a keratitis associated with uveitis; of the 13 patients of Snapper and Pompen,[13] 2 had keratitis, and of the 11 patients of Harrell,[16] 2 had corneal involvement. Both of Reisner's patients who eventually were completely blind had keratitis along with iridocyclitis and chorioretinitis. Meyer [49] reported a case of bilateral keratitis with uveitis and papillitis that culminated in dense opacification with vascularization of the corneas.

Keratitis filamentosa (keratoconjunctivitis sicca) may be an ocular complication of Boeck's sarcoid secondary to involvement of the lacrimal gland with resulting diminution in the secretion of tears. This occurred in a case reported by Ustvedt [14] and in one reported by Leder.[35]

Uveal Tract.—The most frequent ocular lesion encountered in Boeck's sarcoid is an inflammation of the anterior portion of the uveal tract. This usually takes the form of a painless chronic plastic iridocyclitis of variable intensity, associated with little or no pericorneal injection, a marked descemetitis, exudation into the anterior chamber, multiple synechiae and, most frequently, iris nodules. Both eyes are usually affected, one frequently more severely than the other. The time of onset of the ocular lesion bears no relation to the time of appearance of other manifestations of the disease. It may occur at any time in the course of the disease and may even precede any other manifestation by years. The association of the lesion with enlargement of the parotid glands, accompanied by a variable group of symptoms, of which facial paralysis and fever are the most frequent, forms the syndrome of uveoparotid fever (Heerfordt). The clinical appearance of the lesion resembles the form of uveal tuberculosis usually attributed to allergy resulting from hypersensitivity to tuberculoprotein. In most cases the condition responds to local therapy. In others hypotony develops or a considerable increase in ocular tension and there is failure to respond to medical or surgical treatment, the condition terminating in phthisis bulbi and blindness of one or both eyes.

Schumacher,[50] in 1909, and Bering,[51] in 1910, reported the observation of iritis in cases of Boeck's sarcoid. Bloch,[52] in 1914, reported the occurrence of iritis in 5 of 20 cases of Boeck's sarcoid. Plancherel,[46] in 1914, observed a few instances of iridocyclitis accompanying the disease

49. Meyer, F. W.: Lymphogranulomatosis benigna (Boecksches Sarkoid) und Iridozyklitis, Klin. Monatsbl. f. Augenh. **100**:377, 1938.

50. Schumacher: Fall von beiderseitiger Iridocyclitis chronica bei Boeckschem multiplem benignen Sarkoid, München. med. Wchnschr. **56**:2664, 1909.

51. Bering, F.: Zur Kenntnis der Boeckschen Sarcoide, Dermat. Ztschr. **17**: 404, 1910.

52. Bloch, B.: Zur Frage des Boeckschen Lupoids, Arch. f. Dermat. u. Syph. **119**:133, 1914.

and identified the ocular lesions with tuberculosis. In the dermatologic literature, Mylius and Schürmann cited 13 cases [53] and Pautrier [19] added reports [54] of 8 additional cases of Boeck's sarcoid in which iritis or iridocyclitis was observed. Numerous cases of uveitis have been reported in the ophthalmologic literature, including those of Schoeppe,[37] Mylius,[47] Seefelder,[54a] Osterberg,[44] Coppez and Dujardin,[55] Stallard and Tait,[56] Blegvad,[57] Meyer,[58] Rohrschneider,[59] King,[23] Walsh,[24] Meissner,[60] Feld-

53. (*a*) Mylius, K., and Schürmann, P.: Universelle sklerosierende tuberkulose grosszellige Hyperplasia, eine besondere Form atypischer Tuberkulose, Beitr. z. Klin. d. Tuberk. **73**:166, 1929. (*b*) Bering.[51] Bloch.[52] (*c*) Broers, in Versammlung des Vereins Nederlandische Dermatologen, Arch. f. Dermat. u. Syph. **115**:766, 1913. (*d*) Ehrmann: Die Tuberkulide, ibid. **119**:83, 1914. (*e*) Favauge-Bruyel, A. J.: Iridocyclitis Tuberculosa and Boeck's Sarcoid, Nederl. tijdschr. v. geneesk. **66**:1067, 1922; abstracted, Zentralbl. f. Haut- u. Geschlechtskr. **6**:458, 1923. (*f*) Habermann: Sarkoid Boeck, ibid. **21**:560, 1927. (*g*) Hoffmann, E.: Boecksches Lupoid mit Iridocyclitis, Dermat. Ztschr. **26**:17, 1918. (*h*) Hudelo and Rabut: Lupoides disseminées de Boeck, Bull. Soc. franç. de dermat. et syph. **32**:108, 1925; abstracted, Zentralbl. f. Haut- u. Geschlechtskr. **17**:457, 1925. (*i*) van Husen, J.: Ein Beitrag zur Kenntnis der Boeckschen Miliarlupoids und seiner Beziehung zu Erkrankungen anderer Organe, Dermat. Ztschr. **28**:1, 1919. (*j*) Martenstein, H.: Sarkoid Boeck und Lupus Pernio, Arch. f. Dermat. u. Syph. **127**:70, 1924. (*k*) Plancherel.[46] (*l*) Savatard, L.: Benign Lymphogranulomata (Sarcoid), Proc. Roy. Soc. Med. (Sect. Dermat.) **16**:1, 1923; abstracted, Zentralbl. f. Haut- u. Geschlechtskr. **12**:51, 1924. (*m*) Unna, P., Jr.: Ein typischer Fall von Boeckscher, Krankheit. Sarkoid (Miliarlupoid) Boeck Grossknotige und infiltrierende Form, Dermat. Wchnschr. **55**:1203, 1912.

54. (*a*) Postma, C.: Boeck's Sarcoid, Nederl. tijdschr. v. geneesk. **77**:4837, 1933; abstracted, Zentralbl. f. Haut- u. Geschlechtskr. **47**:76, 1934. (*b*) Krosen: ibid. **53**:528, 1936. (*c*) Chevallier, P., and Orinstein, E.: Sarcoides de Boeck avec lésions osseuses spéciales, Bull. Soc. franç. de dermat. et syph. **43**:1818, 1936. (*d*) Koenigstein: Zentralbl. f. Haut- u. Geschlechtskr. **57**:654, 1937. (*e*) Nordin.[48] (*f*) Gordon, H.: Benign Lymphogranulomatosis with Ocular Symptoms, Proc. Roy. Soc. Med. **30**:1057, 1937. (*g*) Tappeiner: Osterrlichische dermatologische Gesellschaft, Zentralbl. f. Haut- u. Geschlechtskr. **59**:373, 1938. (*h*) Troisier, J.; Bariety, M.; Hautefeuille, E., and Ortholan, J.: Maladie de Besnier-Boeck-Schaumann àprécession pulmonaire, Bull. et mém. Soc. méd. d. hôp. de Paris **54**:111, 1938.

54a. Seefelder, R.: Ein neuer Fall von Boeckschem Sarkoid mit Beteiligung des Auges, Arch. f. Augenh. **105**:664, 1932.

55. Coppez, H., and Dujardin, B.: Un cas de maladie de Besnier-Boeck ou lymphogranulomatose de Schaumann à manifestations oculaires, Arch. d'opht. **2**: 497, 1938.

56. Stallard, H. B., and Tait, C. B. V.: Boeck's Sarcoidosis: Case Record, Lancet **1**:440, 1940.

57. Blegvad, O.: Diagnosis of Boeck's Iritis, Acta ophth. **16**:598, 1938.

58. Meyer, F. W.: (*a*) Augentuberkulose und Lymphogranulomatosis benigna (Boecksches Sarkoid, Multiples benignes Miliarlupoid), Klin. Monatsbl. f. Augenh. **102**:76, 1939; (*b*) footnote 49.

(Footnotes continued on next page)

man and Medvedev [61] and Kindt,[62] in addition to numerous others that have been reported as cases of part of the uveoparotid complex. Blegvad [57] and Seefelder [54a] regarded the incidence of uveitis as 10 per cent. Osterberg [44] collected 27 cases of this complication among 500 cases of Boeck's sarcoid in the literature and stated the incidence to be between 5 and 10 per cent, but nearer to 5 per cent. In most of the reported cases the condition was diagnosed as tuberculous uveitis. The following issues have arisen in connection with the lesion: first, whether there is a definitive form of uveitis specific to Boeck's sarcoid and distinguishable clinically from tuberculous uveitis, and, second, whether the lesion is a superinfection or a secondary tuberculous infection comparable to the development of frank pulmonary tuberculosis in the course of Boeck's sarcoid or represents a localization of the disease corresponding to that in the other organs of the body.

Osterberg [44] stated the belief that there is a distinct form of uveitis associated with Boeck's sarcoid but that it is impossible to diagnose it from the clinical appearance without recourse to other manifestations of the general disease. Blegvad,[57] however, stated that Boeck's iritis can be differentiated from tuberculosis by the type of nodule formation, although the serous form of Boeck's iritis cannot be distinguished from the serous form in tuberculosis. According to Blegvad and to Redslob,[63] the iritic nodules in Boeck's sarcoid tend to be larger and have a reddish orange tint, an irregular contour, an uneven surface and an interlacing of fine vessels restricted to the nodule, and on absorption the surface of the iris returns to a perfectly normal appearance; while in tuberculous uveitis the nodules are apt to be smaller and less sharply outlined, are gray to light yellow and circular or oval, have a smooth surface and a vascularization that involves the surrounding iris tissue and leave atrophic areas of iris on absorption. Pautrier [19] defied any oculist to make the differentiation on the basis of iris nodules or other ocular appearances and emphasized that the general examination is essential for diagnosis. He further stated that the histologic changes of the uveal lesion are unknown.

Meyer observed 3 cases [58] of iridocyclitis associated with Boeck's sarcoid. In 1938 he reported a case of this disease associated with severe

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59. Rohrschneider, W.: Tuberculosis of the Eye and of the Lungs and the Negative Tuberculin Reaction, Arch. Ophth. **23**:419 (Feb.) 1940.

60. Meissner, M.: Fall mit Knocheniritis und Blasenbildung der Hornhaut bei Boeckschem Sarkoid, Klin. Monatsbl. f. Augenh. **100**:124, 1938.

61. Feldman, M., and Medvedev, N.: Iridocyclitis in Connection with Boeck's Sarcoid, Vestnik oftal. **15**:49, 1939.

62. Kindt, P.: Three Cases of Nodulate Iritis (Iritis Boeck?), Acta ophth. **18**:38, 1940.

63. Redslob, E.: The Uveal Tract. in Pautrier.[19]

vascularizing keratitis, cloudy vitreous chambers and papillitis, all bilateral. In 1939 he reported 2 additional cases; in one there were papillitis and choroiditis, and in the other, malignant iridocyclitis and secondary glaucoma of one eye and retinal periphlebitis and choroiditis of the other eye. He concluded that Boeck's sarcoid represents very likely an atypical form of tuberculosis and that the ocular lesion which manifests itself in its course or exists a long time before its manifestations is with the highest degree of probability a true tuberculosis of the eye. These views were supported by Rohrschneider, who studied 4 cases of Boeck's sarcoid with bilateral iridocyclitis and nodule formation.

On the basis of a report of 3 cases of nodulate iritis, of presumably Boeck's iritis, and of a study of the literature, Kindt [62] concluded that there does exist a form of iritis clinically resembling tuberculous iritis but that it has another histologic base.

A positive Wassermann reaction may lead to a mistaken diagnosis of syphilitic uveitis and obscure the true nature of the lesion. In the cases of Longcope and Pierson,[11] Harrell [16] and Walsh [24] the role of syphilis came into consideration because of the frequency of positive Wassermann reactions. Reisner,[31] who noted positive Wassermann reactions in 9 of 23 cases of Boeck's sarcoid, regarded the reaction as being a false positive reaction in view of the usual absence of a history of syphilitic infection, the inconstancy of the reaction and the failure to respond to antisyphilitic therapy.

Fundi.—Observations of lesions of the choroid, retina and optic nerve are relatively scant. Choroiditis, or chorioretinitis, has been reported by Hudelo and Rabut,[53h] Tappeiner [54g] Coppaz and Dujardin,[55] Meyer,[58a] Horton, Lincoln and Pinner,[65] Lesne, Coutela and Lévesque [66] and King.[23] Retinal periphlebitis has been reported by Wagner,[67] Meyer [58a] and Walsh.[24] The last observed whitish yellow masses in the fundus with a tendency toward perivascular situation, a picture that he considered possibly characteristic of intraocular sarcoid. Von Bahr [30] described perivasculitis in a case of uveoparotitis. Lesions of the optic nerve are seen as papillitis accompanying uveitis or as papilledema or atrophy of the optic nerve secondary to intracranial localization. Papil-

64. Footnote deleted on proof.

65. Horton, R.; Lincoln, N. S., and Pinner, M.: Noncaseating Tuberculosis—Four Case Reports, Am. Rev. Tuberc., **39**:186, 1939.

66. Lesne, F.; Coutela, C., and Lévesque, J.: Syndrome de Heerfordt, forme particulière de la maladie de Besnier-Boeck-Schaumann, Bull. et mém. Soc. méd. d. hôp. de Paris **54**:9, 1938.

67. Wagner, H.: Boecksche Krankheit als Ursache von Iridozyklitis und Periphlebitis retinalis, Klin. Monatsbl. f. Augenh. **100**:133, 1938.

litis was reported by Meyer [58a] in 2 of 3 cases and by Lemming [68] in 1 case. Salvesen [8] recorded a case of unilateral optic neuritis that was thought possibly to be the result of sarcoid invasion of the nerve.

Intracranial Involvement.—The neurologic manifestations of Boeck's sarcoid have received the attention of Roos.[69] In a small number of cases of intracranial involvement which have been reported, the meninges and various parts of the brain were invaded, and a definite tendency for basal localization was noted. The hypophysial region was involved in cases reported by Tillgren,[70] Snapper and Pompen,[13] Lesne, Launay and Sée,[71] Flandin, Parat and Poumeau-Delille [72] and Walsh,[24] with diabetes insipidus as the clinical picture. In the case of Walsh, in addition to the diabetes insipidus and other systemic manifestations, uveitis in one eye, retinal periphlebitis in the other, bilateral atrophy of the optic nerve and a pituitary type of visual field defect were observed. In the case of Lenartowicz and Rothfeld,[73] reported from the ophthalmic standpoint by Reis and Rothfeld,[74] bilateral papilledema and atrophy of the optic nerve were present, and autopsy disclosed sarcoid infiltration in various parts of the brain, including the base of the brain, the optic chiasm, the optic nerves and one retina. In the case of Lesne, Coutela and Levesque, cited by Pautrier,[19] presenting similar clinical observations and a fatal termination, a like type of intracranial invasion probably occurred. Walsh [24] mentioned a case of Vandergrift in which there was bilateral papilledema and autopsy disclosed sarcoid invasion of the brain and meninges. In the case of an infant with convulsions, changes in the cerebrospinal fluid and fatal termination reported by Naumann,[75] autopsy

68. Lemming, R.: Experimental Study on Positive Tuberculin Anergy in Uveoparotid Fever and in Benign Lymphogranulomatosis (Schaumann), Nord. med. tidskr. **14**:1822, 1937.

69. Roos, B.: Neurologic Aspects of Boeck's Sarcoid, Acta psychiat. et neurol. **13**:41, 1938; Cerebral Manifestations of Lymphogranulomatosis benigna (Schaumann) and Uveoparotid Fever (Heerfordt), Acta med. Scandinav. **104**:123, 1940.

70. Tillgren, J.: Diabetes Insipidus as Symptom of Schaumann's Disease, Brit. J. Dermat. **47**:223, 1935.

71. Lesne, E.; Launay, C., and Sée, G.: Diabète insipide au cours d'une maladie de Besnier-Boeck, Bull. Soc. franç. de dermat. et syph. **42**:1671, 1935.

72. Flandin, C.; Parat, M., and Poumeau-Delille, G.: Sarcoïdes noueuses disseminées avec diabète insipide associe, Bull. et mém. Soc. méd. d. hôp. de Paris **52**:1423, 1936.

73. Lenartowicz, J., and Rothfeld, J.: Ein Fall von Hautsarkoiden (Darier-Roussy) mit indentischen Veränderungen in Gehirn und den inneren Organen, Arch. f. Dermat. u. Syph. **161**:504, 1930.

74. Reis, W., and Rothfeld, J.: Tuberculide des Sehnerven also Komplikation von Hautsarkoiden von Typus Darier-Roussy, Arch. f. Ophth. **126**:357, 1931.

75. Naumann, O.: Kasuistischer Beitrag zur Kenntnis der Schaumannschen "benignen Granulomatose" (Morbus Besnier-Boeck-Schaumann), Ztschr. f. Kinderh. **60**:1, 1938.

revealed sarcoid formations in the falx and tentorium cerebelli. Roos [76] reported a case of bilateral uveitis and bilateral papilledema with neurologic signs in which there was complete recovery. Rothfeld [77] reported a case of Boeck's sarcoid showing disturbances of conjugate movements of the eyes, with diplopia and nystagmus, and several other conditions indicative of intracranial localization.

Mikulicz' Syndrome and Uveoparotid Fever.—Mikulicz' syndrome and uveoparotid fever (Heerfordt), both previously mentioned, have received considerable attention in both the general medical and the ophthalmic literature in connection with Boeck's sarcoid. The histologic identity of the involved glands with the characteristic sarcoid picture, plus the blending of these syndromes, together and in association with other manifestations of Boeck's sarcoid, have led to the conclusions that one of the possible causes of Mikulicz' syndrome is Boeck's sarcoid and that uveoparotid fever is a manifestation or a phase of Boeck's sarcoid. Savin [78] (1934), Cohen and Rabinowitz [79] (1935), Toulant and Morard [80] (1936) and Folger [81] (1936) reviewed the literature on uveoparotid fever, none mentioning Boeck's sarcoid as a possible cause. Gilbert [82] (1940) surveyed the literature on uveoparotid fever and its relation to Mikulicz' syndrome and to Boeck's sarcoid, referring to fifty-six articles that have appeared from 1934 to 1939. He pointed out that only in the exceptional case of uveoparotid fever is the disease restricted to the eye, the parotid gland and the facial nerve. A systemic disease is more frequently present, in which, besides the aforementioned organs, all of the salivary glands may participate, as in Mikulicz' syndrome, or the entire reticuloendothelial system is found to be involved, as is shown by the close relation with Boeck's sarcoid. Restudy of cases reported in the literature support these statements, as is illustrated by both cases

76. Roos, B.: Ueber das Vorkommen der Schaumannschen benignen Lymphogranulomatose (des Boeckschen benignen Miliarlupoids), Ztschr. f. Kinderh. **59**: 280, 1937.

77. Rothfeld, J.: Ein Fall von Lupus pernio mit schweren Gehirnerscheinungen, Klin. Wchnschr. **9**:1030, 1930.

78. Savin, L. H.: An Analysis of the Signs and Symptoms of Sixty-Six Published Cases of Uveoparotid Syndrome, with Details of an Additional Case, Tr. Ophth. Soc. U. Kingdom **54**:549, 1934.

79. Cohen, S., and Rabinowitz, M.: Uveoparotitis, J. A. M. A. **105**:496 (Aug. 17) 1935.

80. Toulant and Morard: A propos d'un cas d'uvéo-parotidite (syndrome d'Heerfordt), Arch. d'opht. **53**:321, 1936.

81. Folger, H. P.: Uveoparotitis (Heerfordt): Report of a Case, Arch. Ophth. **15**:1098 (June) 1936.

82. Gilbert, W.: Ueber Uveoparotitis und ihre Beziehungen zur Mikuliczschen Erkrankung und zum Boeckschen Sarkoid. Ergebnisbericht über die Jahre 1934-1939, Zentralbl. f. d. ges. Ophth. **44**:321, 1940.

reported by Kruskal and Levitt.[83] In the first case the uveoparotid involvement was associated with cutaneous lesions, adenopathy, splenomegaly, increased hilar shadow and, as shown by biopsy of a lymph node, a histologic picture now recognized as typically sarcoid. In the second case (also reported by King,[23] case 6) seven years after the onset of the ocular lesions and when these had entirely subsided, a roentgenogram of the chest revealed changes interpreted as consistent with Boeck's sarcoid. Numerous authors have pointed out the great correspondence between uveoparotid fever and Boeck's sarcoid, including Tillgren, Waldenström,[84] Bruins Slot, Goedbloed and Goslings,[85] Pautrier,[19] Grönblad,[86] With,[87] Jersild[88] and Walsh.[24] Roos,[69] while noting the striking likenesses in neurologic observations between uveoparotid fever and Boeck's sarcoid, emphasized that the cause of each is still obscure and that, though there is much to indicate a common cause, it is still too early to give an opinion on the identity of the diseases.

REPORT OF CASE

History.—G. W., a Negress aged 22, presented herself at the ophthalmic clinic of the Jewish Hospital on April 30, 1940. About Christmas time in 1939 she lost the vision of the left eye. She never had any pain in the eye. There was no history of immediate trauma or of any prior ocular inflammation or defect in either eye. The past and the family history were not significant.

Ocular Examination.—Vision in the right eye was 20/15, and in the left eye it was limited to the perception of light. There were an esotropia of low degree and a moderate blepharoptosis of the left eye. Excursions of both globes were unrestricted.

The right globe was white and the cornea grossly clear; there were several discrete circular whitish precipitates on the posterior surface of the cornea. The anterior chamber was normal in depth, the iris lustrous and of normal texture. The pupil was round and reacted actively to light and dilated well with homatropine hydrobromide solution. The vitreous was clear, and the fundus presented a slightly oval optic nerve head of good color (fig. 2), the inferior margin of which was obscured by a fuzzy translucent grayish white membrane. Along the

83. Kruskal, I. D., and Levitt, J. M.: Uveoparotid Tuberculosis, Am. J. Ophth. **18**:735, 1935.

84. Waldenström, J.: Uveoparotitis and Allied Conditions, with Special Reference to Symptoms from Nervous System, Acta med. Scandinav. **91**:53, 1937.

85. Bruins Slot, W. J.; Goedbloed, J., and Goslings, J.: Die Besnier-Boeck (Schaumannsche) Krankheit und die Uveo-Parotitis (Heerfordt), Acta med. Scandinav. **94**:74, 1938.

86. Grönblad, E.: Mikulicz's Syndrome, Uveoparotid Fever (Heerfordt) and Keratoconjunctivitis Sicca (Sjögren), Acta med. Scandinav., 1938, supp. 89, p. 316.

87. With, T. K.: Is Uveoparotid Fever (Heerfordt) a Manifestation of Benign Lymphogranulomatosis (Schaumann)? Acta ophth. **15**:104, 1937.

88. Jersild, M.: Heerfordt's Syndrome (Uveoparotid Fever): Manifestation of Boeck's Sarcoid, Ugesk. f. læger **100**:765, 1938.

lower borders of the retinal veins and in some places partly covering the vessels, there were small horizontally oval whitish soft-edged spots. These were particularly evident along the course of the inferior nasal vein, which presented a succession of these lesions and which when followed peripherally led to a few large choroidal lesions surrounded by faint gray-black pigment.

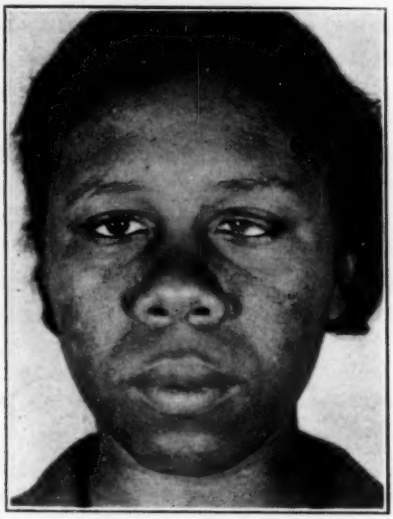

Fig. 1.—Patient with Boeck's sarcoid.

Fig. 2.—Photograph of a painting of the fundus of the right eye showing periphlebitis retinalis and choroiditis.

The left globe was white; the cornea was diffusely hazy, and its entire posterior surface was dense with heavy precipitates of mutton-fat type. The anterior chamber was abnormally deep, with the pupil slightly dilated and fixed to light. The markings of the iris and posterior details were obscured, and there was no fundus reflex. The tension was elevated as determined with the fingers.

A diagnosis of retinal periphlebitis and choroiditis of the right eye and of bilateral uveitis of probable tuberculous causation was made. Atropine, ethylmorphine hydrochloride and hot fomentations were prescribed for the left eye.

General Examination.—There were cutaneous lesions (fig. 3) on the face, arms, forearms, thighs and legs. These consisted of two types: (1) superficial lesions, papular and nodular elevations varying in size from that of a pinhead to that of a pea, sharply outlined and dark red, many surrounded by adherent scales without erythema, and (2) deeper lesions, larger, subcutaneous and nodular, with faint or no surrounding erythema. The cervical, axillary, epitrochlear and inguinal glands were palpably enlarged. Crepitant rales were heard over the left apex and

Fig. 3.—*A*, close-up view of the face, showing the eruption. *B*, typical Boeck sarcoids on the legs.

over the bases of both lungs. There were slight swelling and tenderness over the metatarsal joints of the hands. The blood pressure was 104 systolic and 38 diastolic. During six weeks of hospitalization there was a continuous intermittent fever, with the temperature ranging from 98 to 101 F. An epitrochlear gland and a cutaneous lesion on the leg were excised for microscopic examination.

Roentgen Ray Studies.—A roentgenogram (fig. 4) of the chest revealed increased hilar shadows suggesting nodular deposits and radiating therefrom numerous linear markings confined chiefly to the lower two thirds of the lung beds. A roentgenogram (fig. 5) of the hands revealed several cystlike areas in the heads of the metacarpal bones and phalanges with some periosteal reaction overlying these areas. Roentgenograms of the feet revealed similar involvement

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of the ~~metacarpal~~ TARSAL bones, but to a lesser extent. Studies of the skull, pelvis and gastrointestinal tract disclosed no abnormalities.

Laboratory Studies.—Examination of the blood showed: 74 per cent hemoglobin, 4,400,000 red blood cells and 6,600 white blood cells, with 38 per cent polymorphonuclear leukocytes, 34 per cent lymphocytes, 8 per cent monocytes and 20 per cent staff forms. Hematologic consultation (Dr. Maurice Morrison) revealed "evidence of a left shift of the white blood cells and a slight monocytosis and some changes in the red cells, with normal to slightly increased number of platelets. Study of the bone marrow confirms the peripheral left shift of the white cells. There is no significant change in the red blood cells. There is no evidence of leukemia. The blood picture as shown here is similar to that seen in other cases of Boeck's sarcoid." The Wassermann and Kline reactions of the blood were negative. Urinalysis gave negative results. Spinal puncture was performed, and a clear, colorless fluid was obtained under normal pressure; the reaction to a Wassermann test was negative, and the colloidal gold curve showed no reduction. The sputum showed no acid-fast bacilli.

Chemical examination of the blood gave the following results: sugar, 90 mg. per hundred cubic centimeters; urea nitrogen, 11.5 mg.; nonprotein nitrogen, 28 mg.; total protein, 6.75 Gm.; albumin, 2.79 Gm.; globulin, 3.96 Gm. (albumin-globulin ratio, 0.70); calcium, 9.5 mg.; phosphorus, 3.5 mg.; phosphatase, 3.6 mg.; total cholesterol, 194 mg.; free cholesterol, 67.5 mg. (34.8 per cent), and chlorides, 332 mg. A Mantoux test on May 25, 1940 with 0.001 mg. of old tuberculin elicited a slightly positive reaction; on August 4 and on August 6 the reaction was negative with 0.001 mg. and 0.01 mg. of old tuberculin respectively. The sedimentation rate on June 21 was 75 mm. per hour and on August 16 65 mm. per hour. A smear and culture of aqueous humor aspirated from the left eye showed no micro-organisms, and inoculation of aqueous into the anterior chamber of a rabbit's eye and subcutaneously and intraperitoneally into a guinea pig yielded negative results. Electrocardiographic study indicated severe myocardial involvement.

Course of the Ocular Condition.—On May 4 the vision of the left eye was unimproved; the corneal haze and descemetitis were unchanged, and the pupil had dilated very slightly and irregularly due to multiple posterior synechiae. The tension (Schiötz) was 22 in the right eye and 40 in the left. The peripheral field of vision of the right eye was normal. The condition of the left eye remained essentially the same for several weeks without improvement. Slit lamp examination of the right eye on June 7 disclosed several discrete white precipitates on the posterior corneal surface limited to the lower half of the cornea, a few cells in the aqueous, normal iris structure and granular pigment deposits on the anterior capsule of the lens conforming to the position of the sphincter iridis. In the left eye there were diffuse epithelial bedewing of the cornea, diffuse descemetitis of lardaceous character, marked aqueous flare and an exudate in the floor of the anterior chamber; the iris and posterior details were obscured, and no nodules were evident.

On June 20 an iridectomy was performed. There was secondary hemorrhage on the second day following operation. Within two weeks the blood absorbed, but fresh exudation into the anterior chamber occurred. The iris became updrawn, and the small coloboma at 12 o'clock became occluded. On August 1 vision of the eye was limited to faint perception of light with inaccurate projection; there was pronounced hypotony, such that the plunger of the tonometer failed to

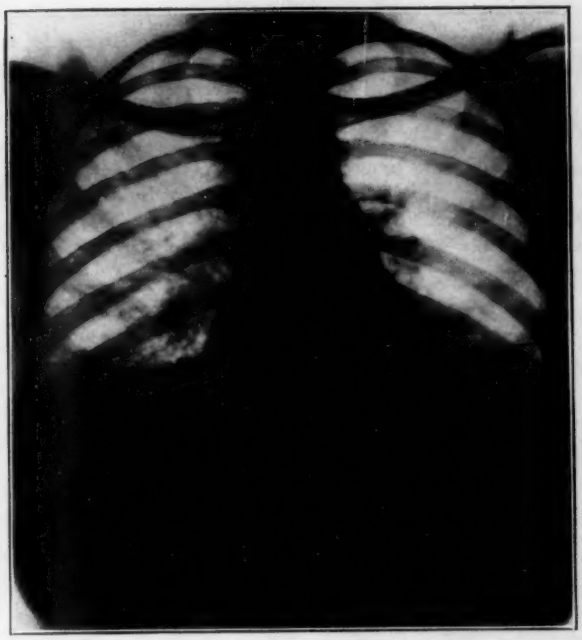

Fig. 4.—Roentgenogram of the chest, showing widening of the hilar shadow and mottling of the lower two thirds of the lungs.

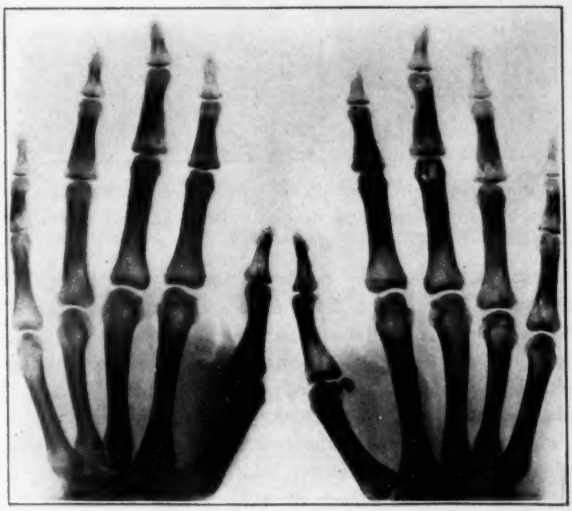

Fig. 5.—Roentgenogram of the hands, showing areas of rarefaction in the heads of the metacarpals and phalanges, a picture practically pathognomonic of sarcoidosis.

register, and a beginning shrinkage of the globe was apparent. On August 2 the globe was enucleated.

The patient was followed in the outpatient department from September 1940 to February 1941. During this period she received a course of roentgen ray therapy to the left arm, left leg and chest. Many of the deeper cutaneous lesions disappeared. The hilar and pulmonary lesions showed no appreciable change, though a general subjective improvement was noted. The keratitic precipitates of the right eye cleared entirely, while the ocular fundus remained unaltered. On Feb. 20, 1941 she was readmitted to the hospital because of convulsive seizures, which were repeatedly observed in the hospital. These consisted of loss of consciousness, turning of the head and eyes to the right, smacking and sucking movements of the lips and tonic contractions of the right extremities, sometimes

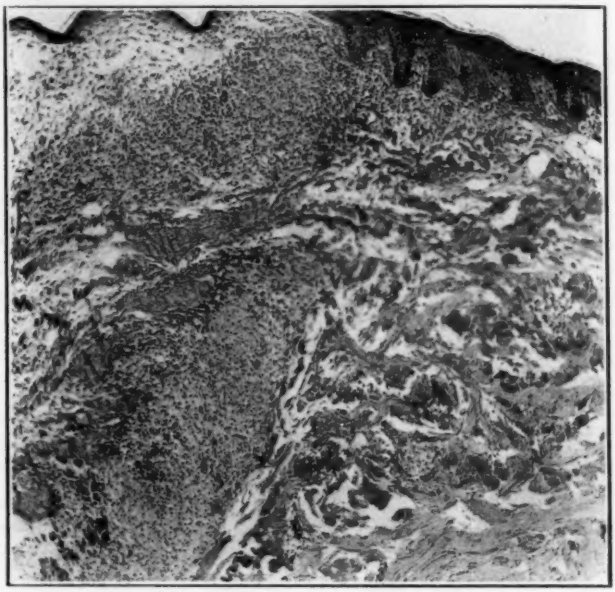

Fig. 6.—Photomicrograph (low power) of a section of the cutaneous lesion on the leg, showing superficial and deeper epithelioid cell nodules.

of all the extremities, followed by headache and pain in the left frontal region. Physical examination disclosed a left hemianesthesia to all forms of sensation and tenderness over the left frontal and parietal bones. There was no papilledema, and the visual field was normal. Roentgenograms of the skull and studies of the spinal fluid showed no abnormalities. Encephalograms (Dr. L. M. Davidoff) revealed normal filling of the ventricular system and subarachnoid cisterns and normal sulci everywhere except in the central area on the left side, where they were widely dilated, suggesting extensive localized cerebral atrophy in this region. The patient was discharged on March 21, 1941 and given dilantin sodium therapy.

Pathologic Examination.—Skin (Dr. Max Lederer): The specimen was a portion of skin with underlying subcutaneous tissue, fixed in Bouin's solution, from a lesion on the leg (figs. 6 and 7). Microscopic study revealed that one

surface was covered by stratified squamous epithelium with keratinizing superficial layers and short blunt rete pegs. The cells of the basal layer contained large quantities of brown pigment. The papillae were broad and contained distended lymphatics and thin-walled capillaries. About some of them was a slight infiltration by small and large mononuclear cells. In the deeper portions there were small and large confluent tubercle-like structures composed of epithelioid cells, with a few scattered areas of small round cells. There were no areas of caseation necrosis. There was an occasional giant cell. Stains for tubercle bacilli were negative.

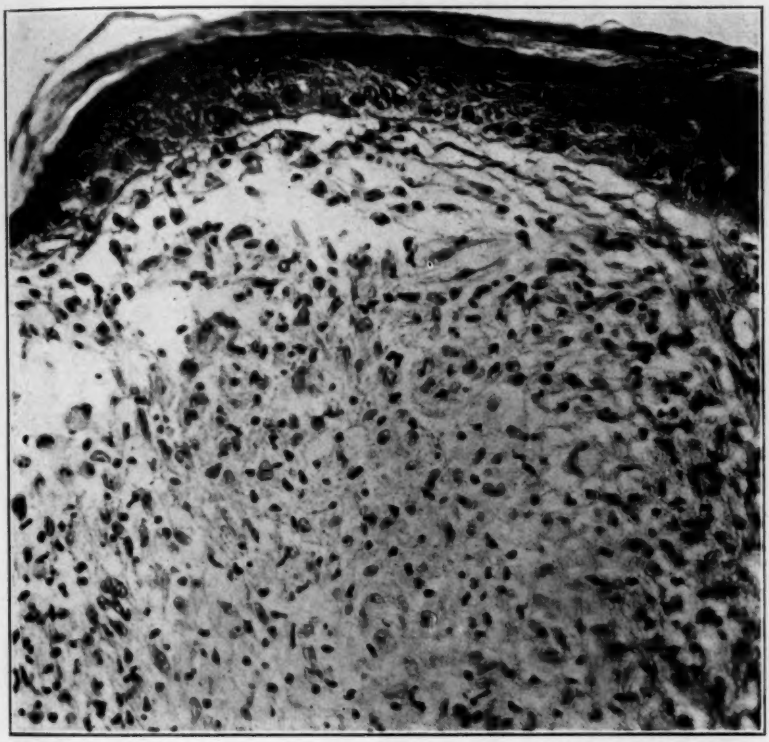

Fig. 7.—Photomicrograph (high power) of the section in figure 6, showing subepithelial edema and the superficial nodule.

Right Epitrochlear Node (Dr. Max Lederer): The specimen was a soft, pink-yellow nodule, measuring 2 by 1.5 by 0.5 cm. The external surface was covered by a delicate transparent membrane. The cut surfaces were a homogeneous gray-yellow. Microscopically, the architecture of the node was completely destroyed (figs. 8 and 9). Only in some places along the border beneath the capsule were there faint remnants of lymphoid tissue characterized by collections of lymphocytes. The picture was that of many miliary and submiliary nodules arranged in the form of tubercles. They consisted of collections of epithelioid cells which externally lay in a concentric arrangement and were

flattened. The central portion showed a looser arrangement. The cells were fairly uniform in size and polyhedral or oval in shape and contained long and slender oval nuclei with a nucleolus. The staining reactions were uniform, giving the nucleus a more or less vesicular appearance. These nodules varied somewhat in size, most of them being small, and were separated from one another by rather delicate connective tissue trabeculae, which were few in number. Occasionally remnants of the lymphoid pulp were seen lying between these lobules. A rare and occasional multinucleated giant cell was also noted. Occasional bands of

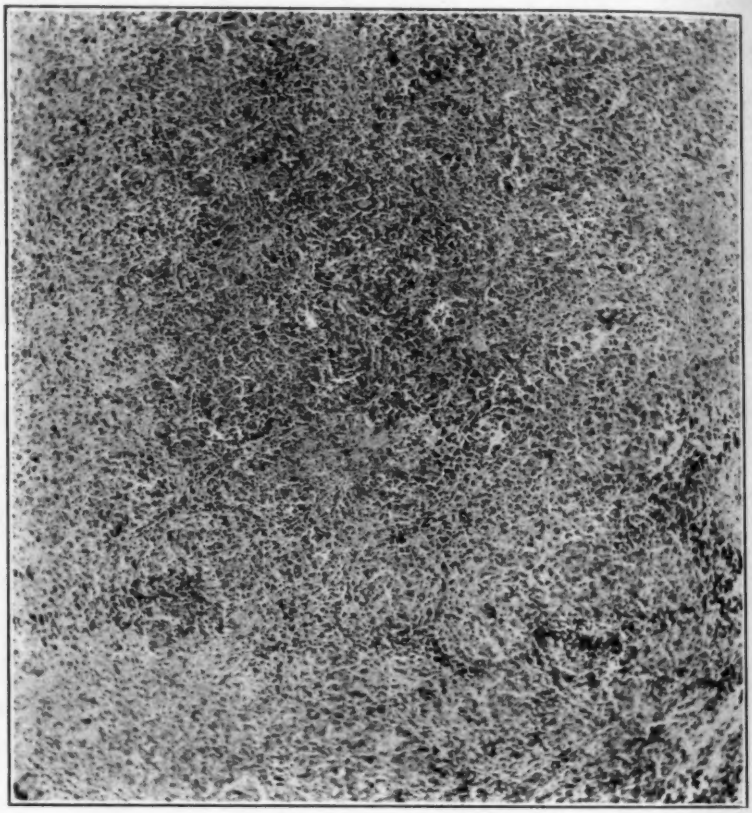

Fig. 8.—Photomicrograph (low power) of a section of an epitrochlear lymph node showing replacement of the normal structure by confluent epithelioid cell nodules.

hyalinized connective tissue were seen scattered throughout the specimen. The picture was that of a granuloma which belonged to the group of Boeck's sarcoid or may have been due to tuberculosis. Stains for tubercle bacilli were negative. Sections stained with hematoxylin and eosin and Mallory stains were studied.

Iris (Dr. Max Lederer): The specimen was an irregular portion of black tissue removed from the left eye. It was broad and composed of broad and thick

fibers. Scattered throughout were numerous pigment cells and well developed thick-walled blood vessels. One surface was lined by a layer of pigment cells. With the Van Gieson stain for elastic tissue there was seen an increase in fibrous tissue; the elastica was fragmented. No tubercle-like structures could be recognized.

Eyeball (Dr. J. Arnold de Veer): The excised left eye was of normal shape but slightly smaller than the average adult eye. It measured 22 mm. anteroposteriorly and 22 mm. in greatest transverse diameter. The scar of a surgical incision was visible at the limbus superiorly. After fixation in Bouin's solution, "windows" were cut in the vertical plane; the specimen was embedded in celloidin

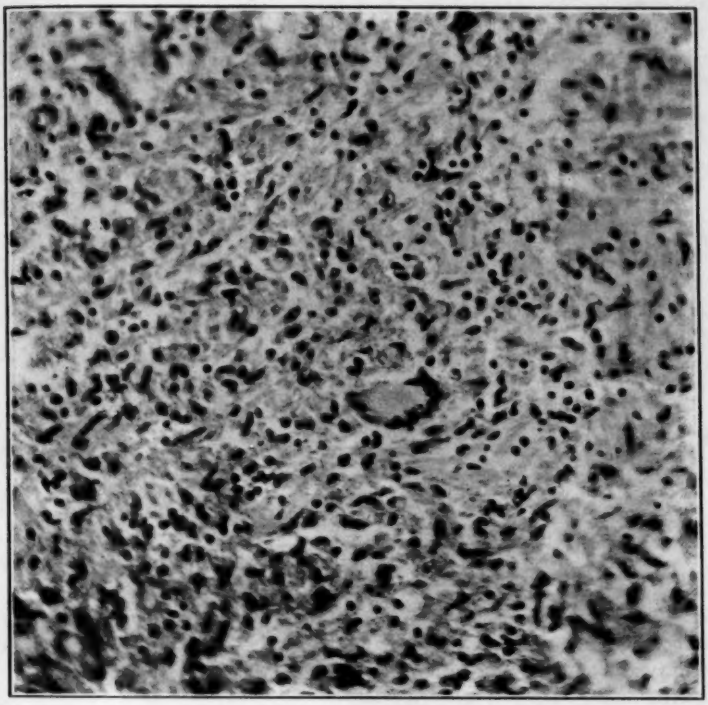

Fig. 9.—Photomicrograph (high power) of the section in figure 8, showing epithelioid cells interspersed with lymphocytes and giant cells.

(a form of pyroxylin), and sections were cut parallel to the vertical meridian. Gross inspection of the stained sections (fig. 10) showed the lens to be drawn upward and forward toward the operative scar. The anterior chamber was small and became shallow superiorly.

Microscopic examination showed extensive pathologic changes in the retina and in the entire uvea. The former, the more widespread, consisted of periphlebitis, endophlebitis and arteritis characterized by mantling of the vessels with lymphocytes and proliferative changes leading to occlusion of the lumen and, in many instances, to complete replacement of the vessel wall by epithelioid cells

(fig. 11). Larger epithelioid nodules, in which origin from vessels was not evident, were also found. These bore a striking resemblance to miliary tubercles but differed from tuberculous lesions chiefly in one respect: there was complete absence of caseation necrosis. Giant cells of the Langhans type were found in moderate numbers. These were not observed to be different in any way from the giant cells of tuberculosis. A sprinkling of lymphocytes and occasional polymorphonuclear leukocytes were found among the epithelioid cells. There was almost complete absence of the peripheral lymphocytic mantle usually present in tuberculosis. Not all of the epithelioid nodules were rounded and discrete. A number of composite clusters, analogous to conglomerate tubercles were found (fig. 12). The changes in the retina were limited to the vascular inner half of the structure, save where a larger nodule protruded into the outer layers or, as in occasional foci, where continuity had been established between epithelioid nodules involving the retina and a contiguous area of choroid. In addition to

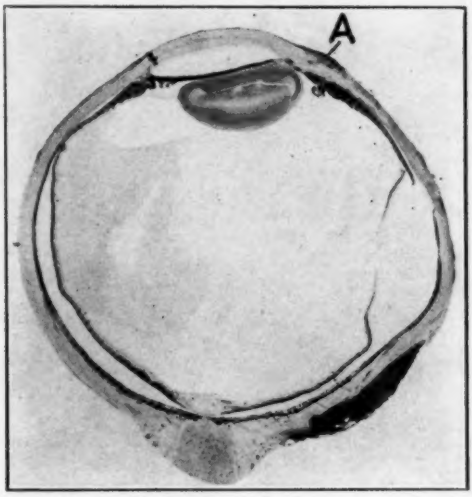

Fig. 10.—Vertical meridional section of the left globe (magnified about three diameters). *A* indicates the scar of an iridectomy incision. The lens has been drawn forward and upward by adhesions in the neighborhood of the scar. The detachment of the retina is artificial.

these focal lesions, the retina contained scattered infiltrating lymphocytes and smaller numbers of polymorphonuclear leukocytes. There was unusual prominence of Müller's supporting fibers, such as is seen in retinal atrophy (fig. 13). Near the optic disk several small vessels streamed out from the retina into the vitreous (fig. 11 *D*).

The optic disk was moderately edematous, and scattered leukocytes were present among the nerve fibers and about the central vessels. The lamina cribrosa was more sharply bowed than usual. No epithelioid structures were found in the nerve stump or its sheaths, and no exudate was present in the intervaginal space.

The cornea in general was normal in appearance. It contained a healed iridectomy wound superiorly. A small stump of iris was found adherent to the posterior corneal surface and to the angle tissue. This stump contained a number

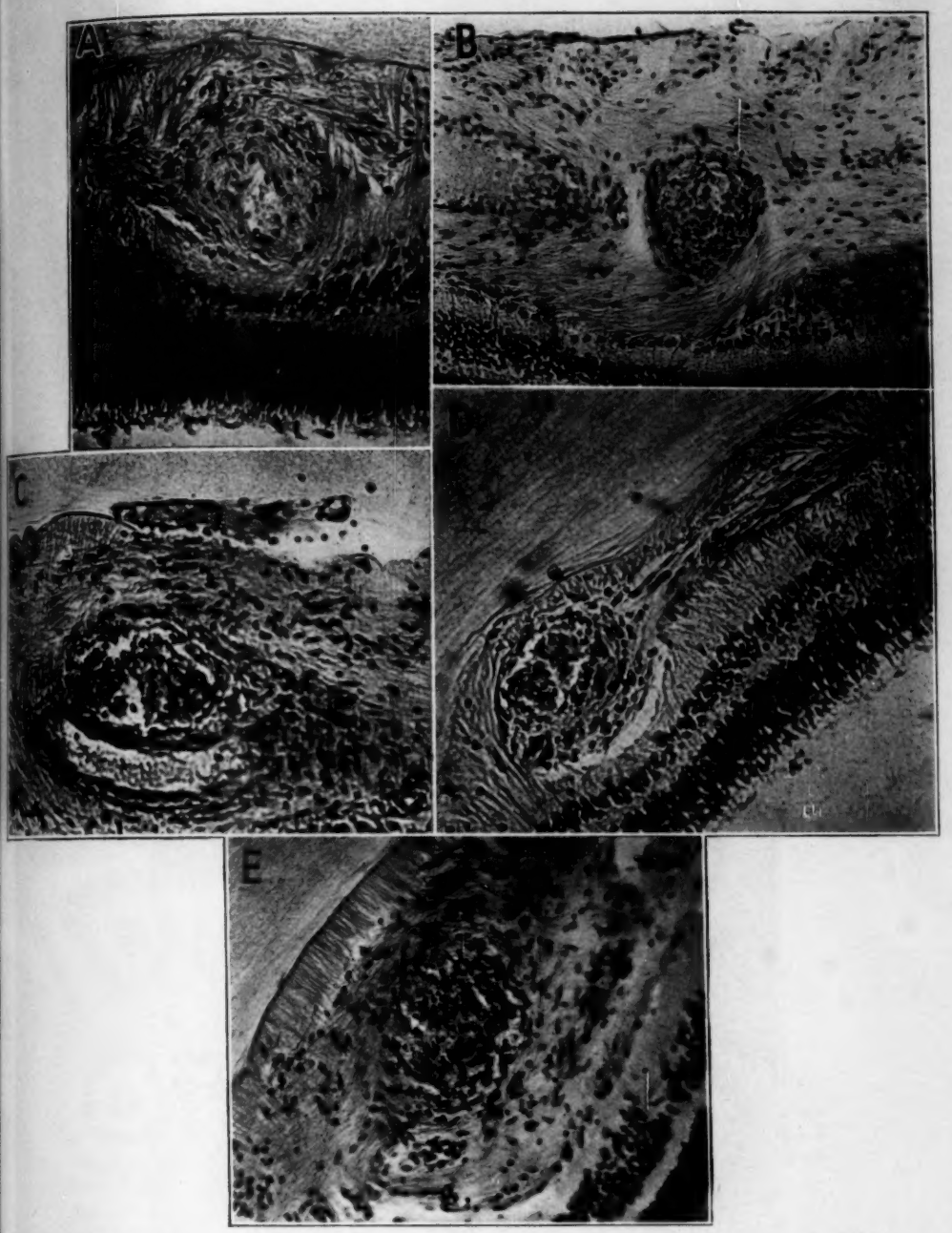

Fig. 11.—Changes in the retinal blood vessels. *A*, the thickened wall infiltrated with lymphocytes. The lumen is compressed but is still patent. *B* indicates an artery (?) with the lumen filled with epithelioid cells. To its left is a vessel, presumably a vein. In *C* small thin-walled vessels can be traced to a point of enlargement and occlusion of one. Another thin-walled patent vessel skirts the outer surface of the nodular lesion. *D* shows two vessels at a point of crossing. The inner one is occluded by the epithelioid mass; the outer one is compressed but not occluded. *E* indicates a small epithelioid nodule in which origin from a vessel is not readily detected. Note the resemblance of this lesion to those seen in the conglomerate lesion in figure 12. It should be pointed out that the inflamed vessels could not be identified with certainty as veins or arteries.

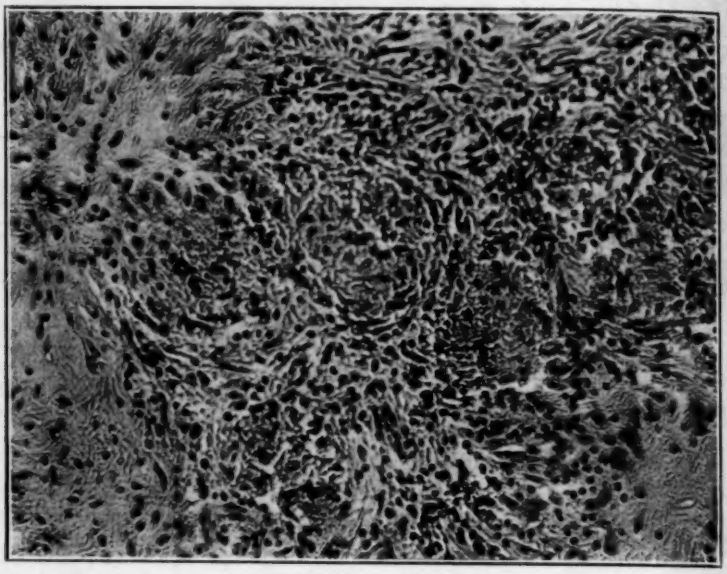

Fig. 12.—Agminated (conglomerate) lesion in the retina.

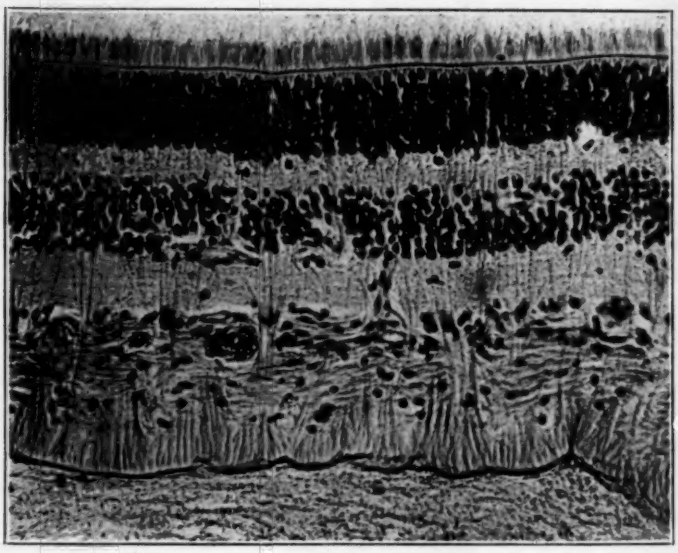

Fig. 13.—A section of the retina near the equator showing prominence of Müller's supporting structures. Note also slight round cell infiltration in the inner layers.

of discrete tubercle-like epithelioid nodules and only scattered, disorganized remnants of the original iris tissue structures.

The lens had been dislocated upward and forward and was united to the stump of the iris and the peripheral part of the cornea by a dense fibrous layer. A fairly thick membrane of fibrous tissue, containing many lymphocytes and polymorphonuclear leukocytes, stretched over the lens capsule in the area of iris coloboma to unite with the inferior pupillary margin.

The iridectomy wound was well healed, but at intervals along the incisional scar through the cornea there were small nodules of epithelioid cells interspersed

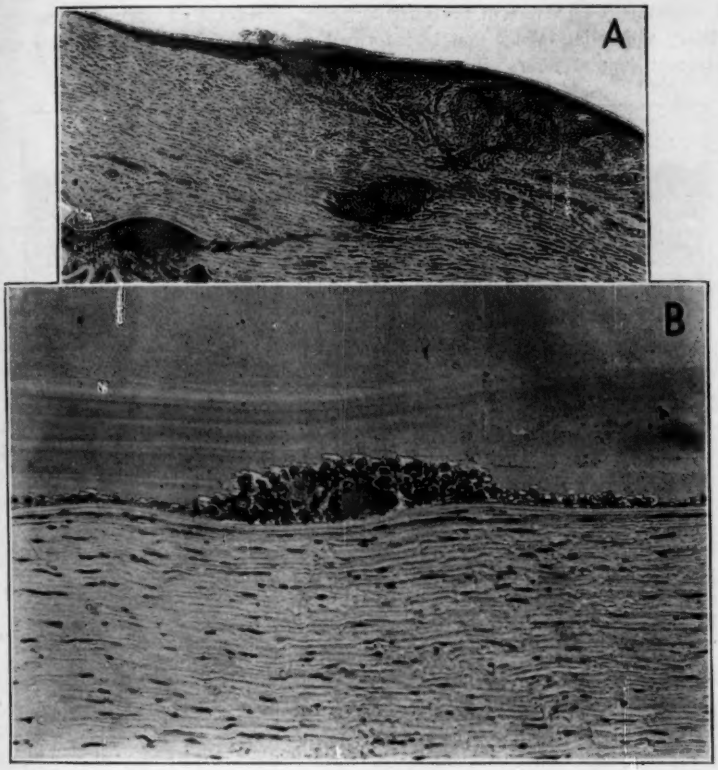

Fig. 14.—*A*, the operative scar at the limbus. To the right epithelioid nodules are present in the episcleral tissue. Two discrete tubercle-like nodules have formed in the line of incision. *B*, one of the larger precipitates on the posterior surface of the cornea. A large giant cell is seen. Note the tuberculoid character of this nodule.

with lymphocytes. A cluster of these tubercle-like structures lay just beneath the conjunctival covering of the wound. These lesions were in almost direct continuity with those in the stump of the iris and in the surgical coloboma and suggested direct inoculation of the wound at the time of operation (fig. 14 *A*).

The angle of the anterior chamber inferiorly was closed by a mass of organizing exudate containing epithelioid nodules. Scattered precipitates were found

on the posterior corneal surface. These were of plastic type, containing lymphocytes, epithelioid cells and occasional giant cells. The larger of these collections suggested early tubercles forming from wandering cells (fig. 14 *B*).

The iris, inferiorly, was adherent to the lens over a broad zone. It was thin and elongated probably because of the displacement of the adherent lens. There was diffuse cellular infiltration of this part of the iris, chiefly of a lymphocytic type, and occasional small epithelioid nodules were also present. One of the latter lay behind the dilator muscle layer and had penetrated the pigment epithelium and protruded into the posterior chamber (fig. 15).

The ciliary body, unlike the iris, contained but few lymphocytes. There were nodular epithelioid lesions in the vascular zone. Several of these had penetrated the ciliary epithelial layers and had formed rather large nodular masses among the adjacent zonular fibers and vitreous (fig. 16).

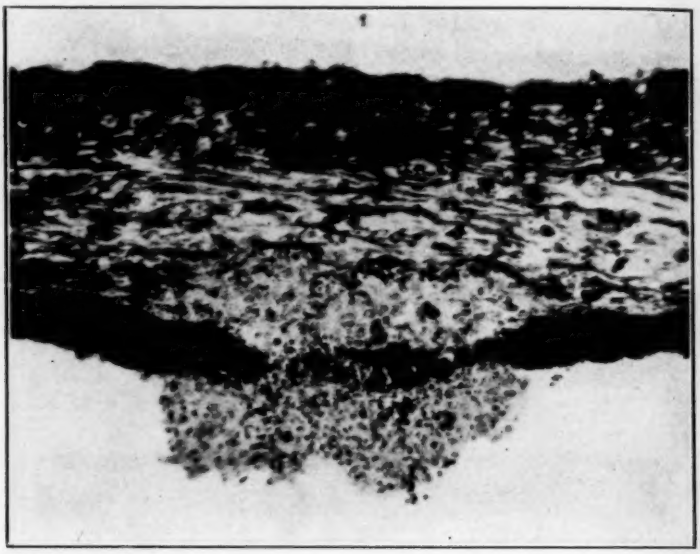

Fig. 15.—A small epithelioid lesion near the posterior surface of the iris has penetrated the pigment epithelial layer and presents in the posterior chamber.

The zonular fibers were festooned with wandering cells. Focal aggregations of these cells approached the structure of the nodular precipitates on the posterior surface of the cornea (fig. 17). There were scattered wandering cells throughout the remainder of the vitreous.

The choroid was less involved in the inflammatory process than the remainder of the uvea. It showed very little diffuse cellular infiltration, but several rather large clusters of epithelioid nodules were found. In one of these there was a point of rupture through the lamina vitrea. No abnormalities were found in the sclera.

The lens was dislocated, as noted, and was distorted by traction of the adhesions to the cornea. There were degenerative changes in the superficial cortical layers about the equator superiorly. Otherwise it appeared normal.

Anatomic Diagnosis.—The diagnosis was Boeck's sarcoid of the eye (endophthalmitis) and atrophy of the bulb.

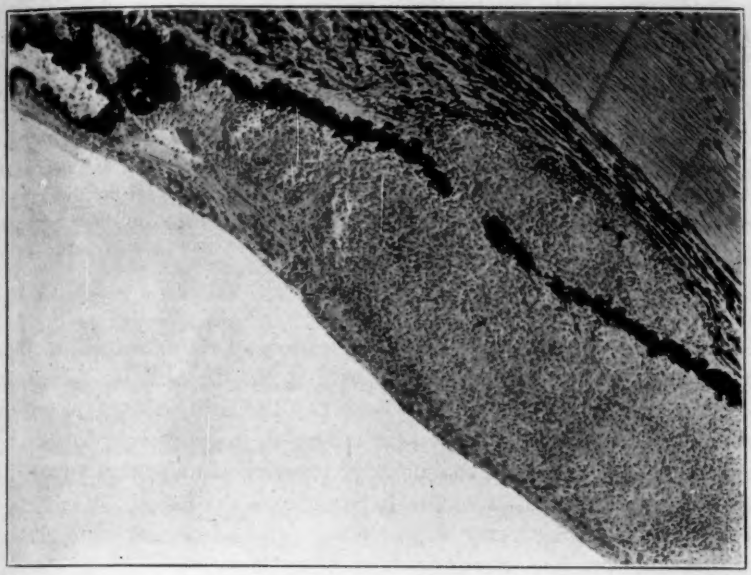

Fig. 16.—One of the larger tubercle-like masses involving the vascular layer of the ciliary body and extending among the zonular fibers. The nonpigmented epithelium has been destroyed in this region. The pigmented layer has been less disturbed.

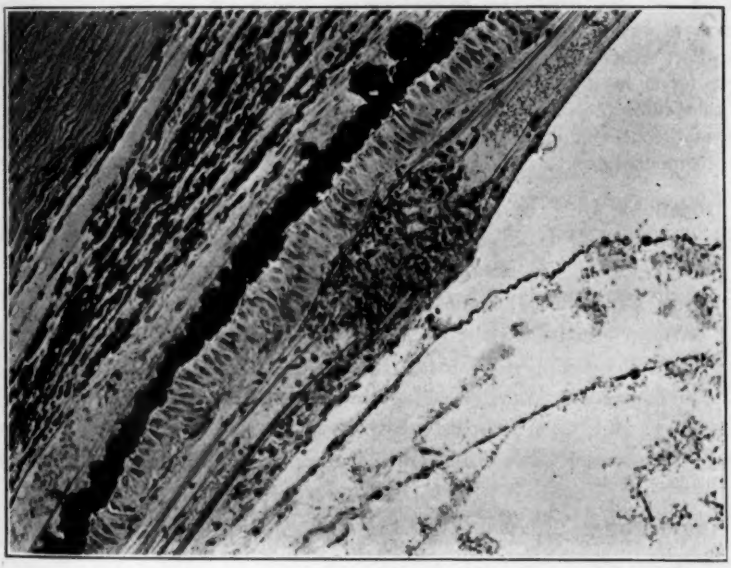

Fig. 17.—A small tubercle-like nodule among the zonular fibers.

The changes in the retina strongly suggest that the nodular epithelioid lesions there may have formed from the vascular endothelium, from cells lodged in the lumens of the vessels or from perithelial cells. The nodules at these sites eventually were found to have entirely replaced all blood vessel structure. That nodules of the same nature may be formed entirely from wandering cells is indicated by the finding of such lesions among the zonular fibers and on the posterior surface of the cornea, where no vascularity can be seen. The development of the characteristic epithelioid nodules within the corneal operative scar and in the episcleral tissue about the operative incision strongly suggests infection of this field during the iridectomy with an organism derived from the iris, from the aqueous, or both.

COMMENT

This case brings to the fore the question whether histologic changes in the eye can be identified as tuberculous in the absence of caseation necrosis and acid-fast bacilli. Weckert,[89] discussing the cases of Rohrschneider, expressed the view that failure to find tubercle bacilli in the lesion does not exclude a diagnosis of tuberculosis and that tuberculosis can be identified by the structural character of the lesion. Verhoeff and Simpson,[90] reporting a case in which one eye had hemorrhagic glaucoma and the other eye had previously been affected with periphlebitis retinalis and in which microscopic study had disclosed collections of epithelioid cells without caseation in the sheath of the optic nerve and occluding the central retinal vein, reasoned as follows:

If tuberculous lesions can be identified by their histologic structure, then this nodule and five small foci of epithelioid cells in the pia, arachnoid and dural sheath of the optic nerve were tubercles. It is true that they were free from caseation, that they caused almost no reaction around them and that no bacilli were found in them, but these facts obtain for most ocular lesions supposed to be tuberculous. . . . The fact that periphlebitis retinalis existed in the right eye in the present case tends to dissolve the doubt that this retinal condition is due to tuberculosis.

Friedenwald,[91] citing another case of hemorrhagic glaucoma presenting a similar type of histologic lesion, stated that it was impossible in his case to decide whether the lesion was tuberculous or due to infection with Brucella. It seems apparent that epithelioid cell nodule formation without caseation is by no means the specific reaction of tuberculosis, as it may be produced by other infectious agents.

The histologic appearance of the intraocular lesions associated with Boeck's sarcoid has been largely presumptive. As has been previously noted, Reis and Rothfeld described the observation at necropsy of sarcoid

89. Weckert, F., in discussion on Rohrschneider.[59]

90. Verhoeff, F. H., and Simpson, G. V.: Tubercle Within Central Retinal Vein: Hemorrhagic Glaucoma; Periphlebitis Retinalis in Other Eye, Arch. Ophth. **24**:645 (Oct.) 1940.

91. Friedenwald, J. S., in discussion on Verhoeff and Simpson.[90]

infiltration of the retina, optic nerves and various parts of the brain in a case presenting bilateral papilledema and atrophy of the optic nerve. Walsh mentioned that sarcoid was demonstrated in the enucleated eye of a patient who had involvement of the uvea and central nervous system. The only detailed description of intraocular localization in Boeck's sarcoid that I have been able to find in the literature is that reported as part of a complete necropsy by Mylius and Schürmann,[53a] in 1929, under the title of "Universal Sclerosing Tuberculous Giant Cell Hyperplasia, a Special Form of Atypical Tuberculosis." The patient was 25 years of age in 1921 at the onset of the disease and had Boeck's sarcoid of the skin and a bilateral recurrent nodular iritis. The phthisical left eye had been removed in 1924. The right eye had been blind and shrunken for a few years prior to death. Epithelioid nodules were found in the lungs, lymph glands, spleen, bones and skin, with extensive fibrous degeneration of the nodules, together with active pulmonary tuberculosis. Microscopic study of the right eye showed collections of epithelioid cells and lymphocytes mostly in the form of noncaseating nodules, with marked hyaline transformation and with few or no giant cells in the iris, ciliary body, choroid, retina and in dense bands of hyalinized scar tissue filling the pupillary space, the posterior chamber surrounding the lens, the vitreous chamber and the subretinal space. The walls of the retinal blood vessels showed pronounced thickening and hyaline degeneration. The retinal veins had surrounding clusters of epithelioid cells. No lesions were found within the lumens of the blood vessels. The cornea and the optic nerve were free of pathologic changes. The changes described by Mylius and Schürmann were those of the terminal phase of involvement, in contrast to those in the present case, which illustrate relatively early pathologic changes.

SUMMARY

Boeck's sarcoid is a chronic relatively benign systemic disorder resembling miliary tuberculosis. Cutaneous lesions are not essential for diagnosis. Involvement of the lungs and of the lymph nodes is almost constant. Osseous changes in the hands and feet, disclosed on roentgen study, are practically pathognomonic. The tuberculin reaction is frequently negative. A characteristic histologic picture, consisting of nodules formed by collections of epithelioid cells interspersed with lymphocytes and occasional giant cells, without caseation necrosis and tubercle bacilli, is found uniformly in every involved structure. Conclusive diagnosis can be made only by biopsy.

One of the favorite sites of the disease is the eye. Lesions of almost every part of the eye and adnexae have been described, including the lids, lacrimal glands, conjunctiva, episclera, cornea, uveal tract, retina and optic nerves. Uveoparotid fever is considered a phase or manifestation

of the disease. Boeck's sarcoid is one of the possible causes of the Mikulicz syndrome. The eye may be implicated secondarily in cases of intracranial localization of the disease with manifestations similar to those seen with intracranial neoplasm. The most frequent ocular lesion is a bilateral iridocyclitis which resembles uveal tuberculosis. This forms probably the most serious lesion of the entire disease, with the exception of intracranial involvement.

A case of Boeck's sarcoid is reported in which there was involvement of the eyes, skin, lungs, lymph nodes, bones and brain, with the diagnosis confirmed by biopsy of the skin and of a lymph node. The right eye presented a low grade descemetitis, retinal periphlebitis and choroiditis. The left eye presented a malignant uveitis and secondary glaucoma, which culminated in hypotension and phthisis bulbi. Microscopic study of the excised left eye showed a widespread nodular uveitis and retinitis, with plastic exudation into the aqueous and vitreous chambers. The origin of tubercle-like lesions from retinal blood vessels was strongly suggested. The exudates in the chambers tended also to assume the appearance of tubercles. Evidently they were formed purely from wandering cells. As in other reported lesions of Boeck's sarcoid, no caseation necrosis was present in the epithelioid nodules, but in all other respects the nodules resembled those of tuberculosis. The development of tubercle-like structures along the line of a recent operative incision tends to support the conception of this disease as an infectious process.

CONCLUSIONS

The uveal lesion in Boeck's sarcoid represents a true localization of the disease rather than a coincident infection. The histologic appearance corresponds to changes observed in other involved organs. The study does not clarify the underlying cause of the ocular lesion. The histologic picture, coupled with the clinical picture of bilateral uveitis associated with periphlebitis retinalis and choroiditis of one eye, would ordinarily be considered of tuberculous causation. The association of the lesion with Boeck's sarcoid makes this assumption doubtful.

In cases of uveitis that present clinically the syndrome of uveal tuberculosis, it is necessary to consider Boeck's sarcoid in diagnosis. The possibility of the ocular lesion occurring as the earliest or even as the sole manifestation of Boeck's sarcoid must be borne in mind. If Boeck's sarcoid is proved to be nontuberculous, as seems likely, then the conception of uveitis with similar clinical and pathologic appearances may have to be altered.

Dr. J. Arnold de Veer furnished the details of microscopic study of the eye and the ocular photomicrographs.

734 Ocean Avenue.

See Page 715

THE STEREOSCOPE AS AN ORTHOPTIC INSTRUMENT

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HANOVER, N. H.

For many years I had no other instrument for orthoptics in my own practice than a simple stereoscope. It is one of oldest and cheapest of all contrivances for this purpose, and probably every ophthalmologist owns one. Although there are many new and complicated instruments to replace it, I still believe that it is one of the best for measuring the muscular conditions of the eyes and for performing exercises and that one is not limited to expensive instruments of orthoptic treatment.

There will be described, first, what can be achieved with any stereoscope, even if nothing is known about its optical properties; then, how to perform exercises with a calibrated stereoscope (one which carries on its shaft the numbers indicating how much accommodation is being exerted as the slide holder is moved to different points of the shaft), and, finally, how accurate measurements can be made with the stereoscope if its optical properties are known and one does not object to making some very simple calculations.

Naturally, a set of stereoscopic charts is also necessary for this purpose. Since it seems that Dr. Wells's selection of charts is the best known in this country, the examples used in this paper will be based on charts of that selection.

At the very start, however, one important reservation must be made. The first condition for proper work with the usual stereoscope is that normal correspondence must be present. Ophthalmologists who are less experienced should follow this rule without exception. Exercises on patients with anomalous correspondence should be performed preferably on a major amblyoscope, e. g., the synoptiscope.[1] It is assumed in all the following considerations that the patients dealt with have normal correspondence.

From the Dartmouth Eye Institute, Dartmouth Medical School.

Wells's stereoscopic cards were used with the permission of the American Optical Company.

1. For the determination of anomalous retinal correspondence the major amblyoscopes are very convenient. However, this condition can be determined accurately, simply and inexpensively with the after-image test, recommended by the late Dr. Bielschowsky (Bielschowsky, A.: Application of After-Image Test in Investigation of Squint, Arch. Ophth. **17**:408-419 [March] 1937).

THE USE OF THE WELLS B_3 CHART FOR DETERMINING THE RELATIVE POSITION OF THE EYES WITH THE STEREOSCOPE

In looking at the B_3 chart of Dr. Wells's selection (chart 1) through any of the ordinary stereoscopes, a vertical (gray) and a horizontal (black) line will be seen to cross at a certain point. The eyes are dissociated, and the vertical line is seen by the left eye and the horizontal by the right eye only. In looking at the vertical line, the line of fixation of the left eye is determined in the horizontal plane by the position of the vertical line, whereas the line of fixation of the right eye in the horizontal plane will assume whatever direction is required by the observer's phoria. Both the vertical and the horizontal line are graduated. The divisions of the vertical line are marked with letters, but this graduation

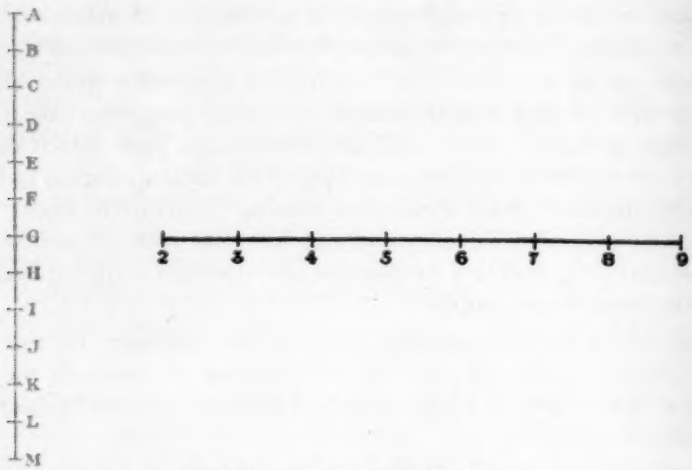

Chart 1.—The B_3 chart of Wells.

will be disregarded in this paper, and only the problem of horizontal ocular movements will be dealt with. The graduation of the horizontal line is marked with the figures 2 to 9. The figure 2 at the left end of the line indicates that this point is 2 cm. to the right of the vertical line. The other figures, increasing to the right, also indicate their respective distances from the vertical line, in centimeters; in other words, they indicate what may be called the horizontal separation between any point on the horizontal line and the vertical line.

It is obvious that when one is looking at the B_3 chart in the stereoscope the vertical line will be seen to cross the horizontal at that point on the latter to which the line of fixation of the right eye is directed. Thus, the intersection indicates the position of the dissociated eyes relative to each other. If the observer is orthophoric (chart 2, *1*) the ver-

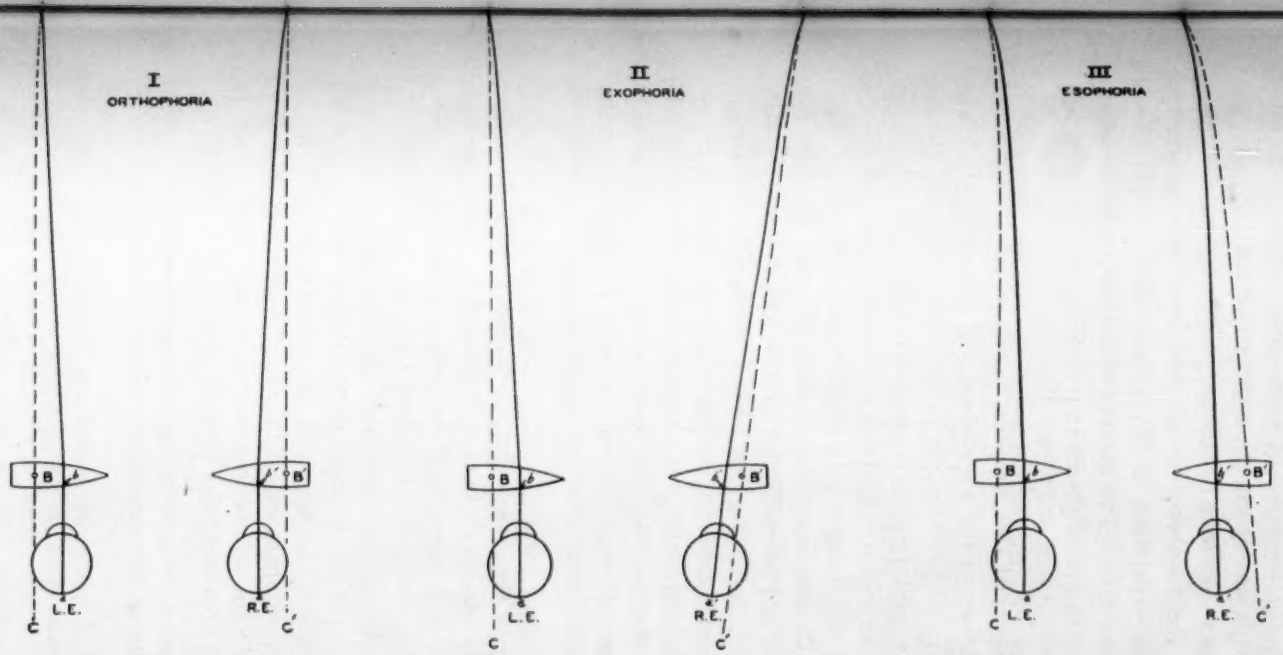

Chart 2.—Cross sections of an ordinary stereoscope and of the B_3 chart as seen by orthophoric, exophoric and esophoric eyes. The separation of the optical centers of the ocular lenses ($B\ B'$) is 8.5 cm.; their power, + 5.25 D. The distance between the centers of rotation of the eyes is 66 mm. The chart is situated at the point of infinity (in the anterior focal plane of the lenses). *I*, orthophoria. Rays emerging from the chart are made parallel by the lenses. Pencils of rays emerging from a point A of the left pattern (ABC) and a point, A', 8.5 cm. to the right of A on the left pattern ($A'B'C'$), are parallel. The lines of fixation (ab and $a'b'$) of the eyes are also parallel. A appears to intersect at A'.

II, exophoria. Pencils of rays emerging from a point A of the left pattern (ABC) and any point, A', more than 8.5 cm. to the right of A on the right pattern (e. g., $A'B'C'$) are convergent. The lines of fixation (ab and $a'b'$) of the two eyes directed to such points must be divergent. A appears to intersect at A'. The drawing also shows that it is not necessary for the lines of fixation to converge at the imaginary combined image of A and A' in order for binocular single vision to be attained.

III, esophoria. Pencils of rays emerging from a point A of the left pattern (ABC) and any point, A', less than 8.5 cm. to the right of A on the left pattern (e. g., $A'B'C'$) are divergent. The lines of fixation (ab and $a'b'$) of the two eyes directed to such points must be convergent. A appears to intersect at A'.

tical line will seem to cross the horizontal at a certain point.[2] In exophoria (chart 2, *II*) the point of intersection will be more to the right, as the right eye is turned out. In esophoria (chart 2, *III*) the lines will be seen to cross somewhere farther to the left, the right eye being turned in. Since the numbers on the horizontal line indicate the amount of horizontal separation, it can be said that the two lines of sight in exophoria are directed to points on the chart with the greater horizontal separation and in esophoria to points with the lesser horizontal separation.

Now let it be assumed that the slide holder is set at the anterior focal plane of the lenses of the stereoscope. If the stereoscope is not calibrated, some very fine print[3] is put in the slide holder, and the slide holder is pushed back until the print is just barely legible. If the observer is emmetropic or if his vision is properly corrected, he will set the slide holder accurately at this distance. In the ordinary stereoscopes usually equipped with +5.25 D. lenses, this is about 19 cm. from the front surface of the lenses, and on calibrated stereoscopes it is marked as ∞, or the point of infinity, indicating that when a stereogram is observed at this distance no accommodation is necessary, the rays entering the eyes being parallel. It is improbable that accommodation should relax fully when an object is observed near at hand which fails to produce the impression of infinity, although the rays entering the eyes are parallel. However, the possible error is of no significance for the purpose in question.

With this setting of the slide holder the B_3 chart will indicate a certain separation of the observer's lines of fixation, i. e., a certain phoria. It may be called phoria for infinity, if one bears in mind the restriction just given. If, for instance, the two lines cross at figure 8 the chart indicates (1) that the line of fixation of the observer's right eye is directed to a point 8 cm. to the right of the vertical line or, generally speaking, that the lines of fixation of the dissociated eyes are directed to points on the chart 8 cm. apart and (2) that any stereogram with a horizontal separation of 8 cm. will be fused at this setting of the stereoscope without the necessity of convergence or divergence.

If the slide holder of the stereoscope is drawn nearer to the eyepiece, an increasing amount of accommodation will be necessary for the two

2. How the point of intersection depends on the separation of the optical centers of the ocular lenses of the stereoscope will be discussed in another part of the paper.

3. The author used a postage stamp and tried to read the signature of the artist.

lines of the B_3 chart to be seen clearly.[4] The accommodative effort in its turn stimulates the convergence, thus changing the position of the two eyes relative to each other. That this is really the case is indicated by the fact that while the slide holder is shifted the vertical line seems to move from right to left, which means that with the line of sight of the left eye fixed the line of sight of the right eye travels to the left along the horizontal line. If the lines appeared to cross at figure 8 without accommodation, the lines of fixation of the two eyes will now be directed to points of lesser horizontal separation, and it will be possible to fuse without the necessity of fusion movements only stereograms having a separation of less than 8 cm.

It may be called a general rule that the nearer the slide holder of the stereoscope is drawn to the eyepiece (the more accommodation is elicited), the smaller will be the horizontal separation of stereograms

Distances of Slide Holder from Eyepiece in a Stereoscope for Accommodation Values of 0 to 3.5 D. if the Power of the Ocular Lenses is + 5.25 D.

Accommodation, in Diopters	Distances, in Centimeters
0.0	19.0
0.5	17.4
1.0	16.0
1.5	14.8
2.0	13.8
2.5	12.9
3.0	12.1
3.5	11.4

that can be combined easily; vice versa, the smaller the separation of the stereograms at which one wishes to look, the closer must the slide holder be drawn to the eyepiece in order for comfortable fusion to be obtained.

Thus far it has been shown that with the use of the B_3 chart the stereoscope gives valuable information about the relative position of the eyes, or, as it may be called, the phoria, and the relation of the latter to accommodation. This information is of even greater accuracy if the point of infinity of the stereoscope being used is known, the more so if the instrument is calibrated for accommodation. In the table are given

4. On the calibrated stereoscopes these amounts of accommodation are indicated (in inches or diopters) on the shaft of the instrument. If only the simple type stereoscope without such calibration is at hand, this can be accomplished once and for all by putting, for instance, + 0.50, + 1.00 or + 1.50 D. over the correction of the observer, who then tries to read fine print (e. g., the postage stamp) with the slide holder as far from the eyepiece as possible. The respective distances will indicate the necessary amounts of accommodation with an accuracy sufficient for the purpose if the slide holder is set at these distances (of course, only if no additional correction is worn). The calibrations should be performed monocularly, their accuracy being checked first with one eye and then with the other.

the distances at which the chart must be placed from the lenses for amounts of accommodation between 0 and 3.5 D., with use of a stereoscope with +5.25 D. spherical lenses. The displacement of the vertical line that occurs when the chart holder is drawn from the point of infinity to the eyepiece is a rather accurate clinical method of judging accommodative convergence coupled with any given amount of accommodation.[5] The method is especially valuable since the phoria at "infinity" and at any desired accommodation can be measured with the same instrument and the same target, with a continuous increase of accommodation. The mental attitude of the patient is therefore not changed in any way.

THE B_3 CHART OF WELLS AS THE STARTING POINT OF FUSION EXERCISES WITH THE STEREOSCOPE

It has been stated that the B_3 chart gives the necessary information concerning the horizontal separation of those stereograms that will be combined most easily at any chosen setting of the stereoscope. Thus, the determination of the horizontal separation of the lines of fixation with the aid of the B_3 chart is the first and most important step in proper orthoptic exercises with the stereoscope.

The latter idea has already been elaborated by Javal. He used for this purpose the charts now incorporated in the Wells set as B_1, B_2 and and B_3. The B_3 chart is the most accurate. If, for instance the B_3 chart indicates 7 at a certain setting of the slide holder, a stereogram must be selected in which the horizontal separation of corresponding parts of the patterns is 7 cm., because they will then be superposed most easily, provided the setting of the slide holder has not been changed. Any charts with a smaller horizontal separation than 7 cm. (such charts are contained in series H and I of Dr. Wells's selection, see chart 3) will require additional convergence without accommodation, i. e., necessitate a fusional convergence movement of the eye. Thus, in exophoria[6] a stereogram with a separation of 6 cm. is tried, and then one with a separation of 5 cm., etc., this separation being decreased until persistent double images indicate that the amplitude of fusional convergence has been exceeded. The exercise, however, will be of value only if the dis-

5. Accommodative convergence is that amount of convergence which accompanies the impulse for accommodation in contradistinction to fusional convergence, which is the amount of convergence necessary to establish binocular single vision if any form of heterophoria is present. Since no fusion is possible when looking at the B_3 chart, the convergence indicated by the movement of the vertical line to the left when the slide holder is drawn toward the eyepiece is pure accommodative convergence.

6. For the sake of simplifying the presentation, no attempt is made in this paper to differentiate between phorias and tropias. The conclusions arrived at are valid for both.

tance between the slide holder and the eyepiece has not been changed at the same time. Otherwise, a change in the amount of accommodative convergence will conceal the effect of the exercises on the fusion faculty.

In exophoria for distance vision the exercises have to be executed at the point of infinity. In exophoria for near vision (convergence insufficiency) the exercises have to be performed with gradually increasing amounts of accommodation. This does not mean that, contrary to belief, any stereogram of a constant separation is put into the slide holder and drawn gradually nearer to the eyepiece. It has already been pointed out by Maddox [7] that such a procedure exerts relative divergence and is certainly of no use in exophoria, since in this condition the purpose of the orthoptic treatment is to develop the faculty of fusional *convergence.*

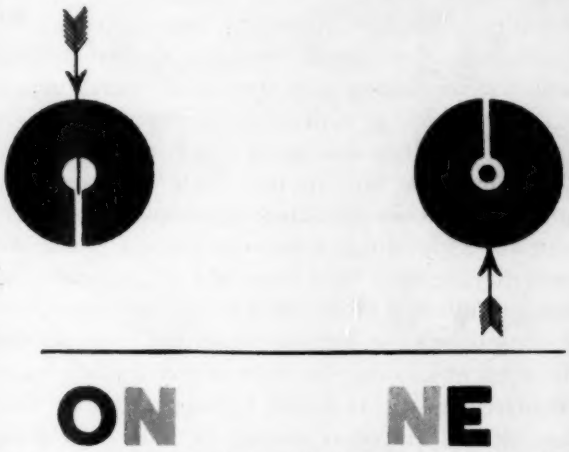

Chart 3.—Examples of the Wells charts (series H and I) for fusion exercises and breaking down suppression, with variable horizontal separations. The distances between corresponding points of the two patterns vary in the different charts.

In fusion exercises with the stereoscope the slide holder must be set at a certain point of the shaft and kept there. So, in the case of exophoria for near vision the first step of a correct exercise is to set the slide holder at a certain point of the shaft, e. g., at the point marked + 1.00 D. To see clearly any stereogram at this point 1.00 D. of accommodation will be necessary. The second step is to ascertain with the aid of the B_s chart the separation of the dissociated lines of fixation of the patient at this setting. As it is desired to perform convergence exercises in a case of exophoria, stereograms with a gradually diminishing separation must be used, without, however, changing the setting of the stereoscope. The whole exercise must be executed with exertion of 1.00 D. of accom-

7. Maddox, E. E.: The Bearing of Stereoscopes on the Relation Between Accommodation and Convergence, Brit. J. Ophth. **11**:330-337, 1927.

modation. If, now, it is desired to proceed with convergence exercises with a greater amount of accommodation, the chart holder will have to be set at the point on the shaft marked, e. g., +2.00 D., indicating the demanded amount of accommodation. It would be wrong to start the exercises with stereograms having the same separation as that just used. This would actually enforce divergence, since the patient would have to be induced to direct his lines of fixation with 2.00 D. of accommodation to the same points as with 1.00 D. of accommodation. On the contrary, the initial separation of the patient's lines of fixation at this new setting of the stereoscope must again be ascertained by means of the B_3 chart, and further convergence exercises must again be executed by using stereograms of less and less separation. The chart holder must not be moved during the exercises.[8]

In esophoria the procedure is similar. First the slide holder is set at the desired distance. Next the B_3 chart is consulted, and the exercises are begun with a stereogram of such horizontal separation as is indicated by the chart. Then a change is made to stereograms whose separations increase step by step. Such divergence exercises will not only increase the divergence amplitude but, in turn, help to relax any spasm of accommodation and uncover any latent hyperopia. However, it is only by maintaining the initial distance between the slide holder and the eyepiece that such exercises will be of value and will indicate what progress has been made in unlinking faulty accommodation-convergence linkages.

In cases of esophoria for distance vision the exercises must be performed at the point of infinity. In cases of convergence excess for near vision (encountered mostly in latent hyperopia and in young myopic persons whose defects are overcorrected or have been corrected fully only recently) exercises with gradually increasing amounts of accommodation (the distance between the slide holder and the eyepiece being decreased) are advisable. Again it must be emphasized that the slide holder must not be drawn toward the eyepiece while the patient looks at a chart.

One starts, for example, by setting the slide holder for 0.50 or 1.00 D. of accommodation, using the B_3 chart to determine the initial position of the patient's lines of fixation for this amount of accommodation. One then passes on to stereograms with a gradually increasing horizontal separation, but without changing the position of the slide holder. The next step is to increase the amount of accommodation (the slide holder being drawn nearer). Again chart B_3 must be used, so as to determine the initial separation of the dissociated lines of fixation, and finally the stereograms with the gradually increasing separation.

8. It will be explained in another part of the paper what effect the shifting of the slide holder has when one is looking at a stereogram.

It goes without saying that the stereoscope equipped with variable prisms, or the stereocampimeter or the phoro-optometer, can also be used for such exercises. One starts with the B_3 chart to get the horizontal separation of the stereogram fused most easily, but it will not be necessary to change this. The convergence or divergence exercises can be given by adding prisms base out or base in, while the stereogram is kept in the slide holder.

WELLS'S B_3 CHART AS THE STARTING POINT OF STEREOSCOPIC EXERCISES WITH STEREOGRAMS OF FIXED SEPARATION

The stereograms of Wells's series H and I are printed in various horizontal separations for use in the previously described fusional ampli-

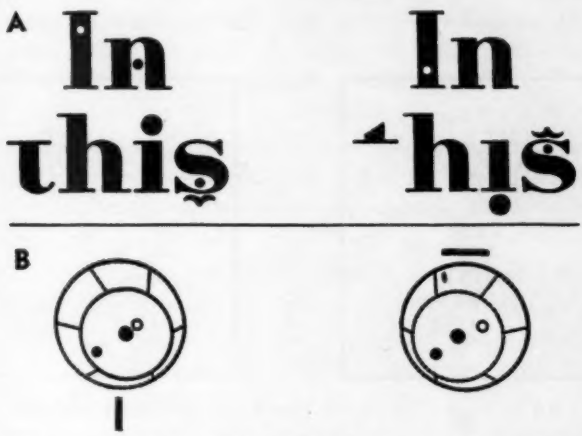

Chart 4.—*A*, an example (G_1) of the charts for developing simultaneous binocular vision and breaking down suppression, with the fixed separation of corresponding points of the patterns of 6 cm.

B, an example (E_3) of the charts for developing depth perception with a fixed separation of the patterns of about 6 cm.

tude exercises, for which they are very valuable. Most of the charts, however, contained in the other series, as well as the majority of those designed by Javal, Dahlfeld and Hegg, for developing binocular simultaneous vision and depth perception and for breaking down suppression (e. g., F, G and E of the Wells series) are, however (and one may say unfortunately), printed with a uniform horizontal separation of 6 mm. (chart 4). The reason for this will be discussed but it is desired here to emphasize that they can be used properly only if at the beginning of the exercise the patient sets the slide holder of the stereoscope, with the aid of the B_3 chart, so that he sees the lines cross at figure 6. This will of course require different amounts of accommodation with different

patients. Since such exercises are usually performed by patients who have poor binocular function owing to suppression, amblyopia or low fusional amplitudes, the exercises with these charts should, at least in the beginning, be performed with this setting of the stereoscope. It will facilitate fusion and make fusion movements unnecessary.

The J series of the Wells charts (chart 5) are excellent for fusion training. They contain two rows of words with a diminishing lateral separation from top to bottom. For convergence exercises the slide holder with the B_3 chart must be set at such a distance that the lines of the chart cross at 6. The reason for this is that the top words of the J_1 or J_2 chart are 6 cm. apart. At this setting even a person with a poor convergence faculty will be able to fuse the two top words. He will have to learn, in the course of the exercise, to combine as many as possible of the following pairs of words into one. Such fusion convergence exercises

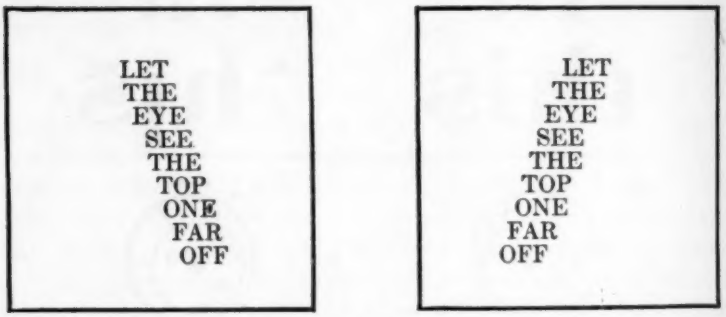

Chart 5.—An example (J_2) of the charts for developing fusional convergence (divergence).

are absolutely correct and require neither calculations nor data on the stereoscope. The convergence is stimulated without the help of additional accommodation; the slide holder, however, must not be moved during the entire exercise. For fusion-divergence exercises the slide holder must be set in such a way (with the aid of the B_3 chart) that the patient sees the lines of this chart cross at figure 5, as the lowest words of the J_1 chart are about 5 cm. apart. If the patient has a higher degree of esophoria or esotropia, he may have to start with chart J_2, in which the separation of the lowest words is about 4 cm. In that case the slide holder must be set so as to cause the lines of the B_3 chart to cross at 4. After such a setting of the slide holder, the patient starts with his divergence exercises by trying to combine the next higher pair of words into one.

It is easily understood that exercises with the J charts cannot, of necessity, be performed by the same patient at different settings of the accommodation. Convergence exercises must start by the patient setting

the B_3 chart at 6, which means that he has exerted a certain individual amount of accommodation. For the divergence exercises the slide holder must be drawn in to such a point that the lines of the B_3 chart cross at 4 or 5. This again means one particular setting of the accommodation. It has been seen that exercises with the charts of series H and I are much more flexible, as the slide holder can be set at will for infinity or for any amount of accommodation and the separation at which the exercises should start can then be determined by means of the B_3 chart. In spite of this one disadvantage, the exercises with the J charts are excellent and effective, especially from a psychologic point of view. Most patients, starting with a very poor fusional amplitude, find the greatest encouragement when they themselves can check the progress they have already made and feel that they are doing better if they can fuse an increasing number of pairs of words in following sessions. Besides, if fusion is broken it is easy to start over again, as the pair of words with the separation for easiest fusion is always at hand. A further reason why I like to use these charts is that I have seen them give the first experience of depth to patients who had never had depth perception. They learn to "feel" their convergence when glancing from top to bottom of the row, and this proprioceptive sensation of convergence may be one of the links in the sensation of depth.

In summarizing, it might be said that it is remarkable how much can be done with such an inexpensive and simple apparatus as the stereoscope. None of the calculations, formulas or tables recommended by earlier authors, which tend to discourage the beginner, seem to be necessary. The B_3 chart takes care of most of the problems involved, as it gives at any point on the individual instrument the necessary and sufficient information concerning the coupled conditions of accommodation and convergence and indicates the starting point for proper stereoscopic exercises, even if no information regarding the optical properties of the stereoscope is at hand. It has been seen, however, that the usefulness of the stereoscope is enhanced if an instrument can be obtained with the necessary amounts of accommodation marked on its shaft or if the necessary trouble is taken to make this calibration on the instrument.

Still better and more accurate work can be done, however, with the stereoscope if the power and the separation of the optical centers of its lenses are known. In discussing these factors it will be impossible to avoid a few simple calculations.

SHORT OUTLINE OF THE OPTICS OF THE ORDINARY STEREOSCOPE

The separation of the ocular lenses of most of the Brewster-Holmes stereoscopes now commonly in use is 8.5 cm. This separation is 2.5 cm. greater than that of the aforementioned stereoscopic charts generally

used for squints, which were developed in France, Germany and Switzerland in the last half-century and have been adopted also in Dr. Wells's selection. Hence, the lenses of the stereoscope when used to view a stereogram with a separation of 6 cm. have a prismatic effect, base out, and induce a convergence of the lines of fixation, this effect being the stronger the greater the convexity of the lenses. This considerable separation of the lenses had its origin in the erroneous conception that convergence of the lines of fixation at the "imaginary" fused image [9] facilitates the mental process of "fusing" the two patterns of the stereograms. This convergence, however, is superfluous, since, according to Hering's law of the common visual directions, any two points to which the lines of fixation of the two eyes are directed will be fused so as to appear in one direction, the common visual direction. Furthermore, this convergence not only is superfluous but is actually not present if the horizontal separation of the two patterns of a stereogram is identical with the optical separation of the lenses (chart 2, *I*) and gives way to real divergence (chart 2, *II*) if the separation of the two patterns of the stereogram is greater than that of the lenses. Thus, the prismatic effect and the amount of convergence necessary to fuse the two patterns of a stereogram into one depend on the difference between the horizontal separation of the two patterns of the stereogram and the optical separation of the ocular lenses and not on the absolute amount of the latter (Maddox [7]). The prismatic effect can be calculated according to the well known Prentice rule, which states that the prismatic effect, in prism diopters, is equal to the product of decentration, in centimeters, times the power of the lens, in diopters: prismatic effect = decentration $\times$ power.

In the stereoscope two lenses must be taken into account. If the separation of the optical centers of the ocular lenses is, as usual, 8.5 cm. and the separation of the patterns of a stereogram 6.5 cm., the difference being 2 cm., the decentration of each of the patterns will be half of this distance, i. e., 1 cm. (chart 6 *I*). If the power of the lenses is, as usual, +5.25 D., the prismatic effect of each lens will be, according to Prentice's rule, $1 \times 5.25 = 5.25$ prism diopters. The two eyes together will have to exert $2 \times 1 \times 5.25 = 10.5$ prism diopters of convergence in order to combine the patterns into a single image. Thus, Prentice's rule has to be modified for the stereoscope as follows: The convergence, in prism diopters, necessary to fuse stereoscopic patterns is equal to the product of the power of the ocular lenses, in diopters, times the difference between the separation of the lenses and the patterns, in centimeters.

As the horizontal separation of the two patterns of the usual stereogram is, as mentioned, 6 cm., the difference between the separation of

9. Wells, D. W.: The Stereoscope in Ophthalmology, revised ed., Boston, E. F. Mahady Co., 1928, p. 51, fig. 17.

the optical centers of the lenses and that of the patterns is $8.5 - 6.0 = 2.5$ cm., and the convergence necessary for fusion will be $2.5 \times 5.25 = 13.12$ prism diopters. Such an amount of convergence is too much, since most people could not exert it easily without accommodating at the same time. The inability to exert such a convergence explains why many persons see crossed double images when looking at the usual stereoscopic training charts when set at the point of infinity (where, of course, no accommodation is necessary). It is much easier to fuse the stereograms when

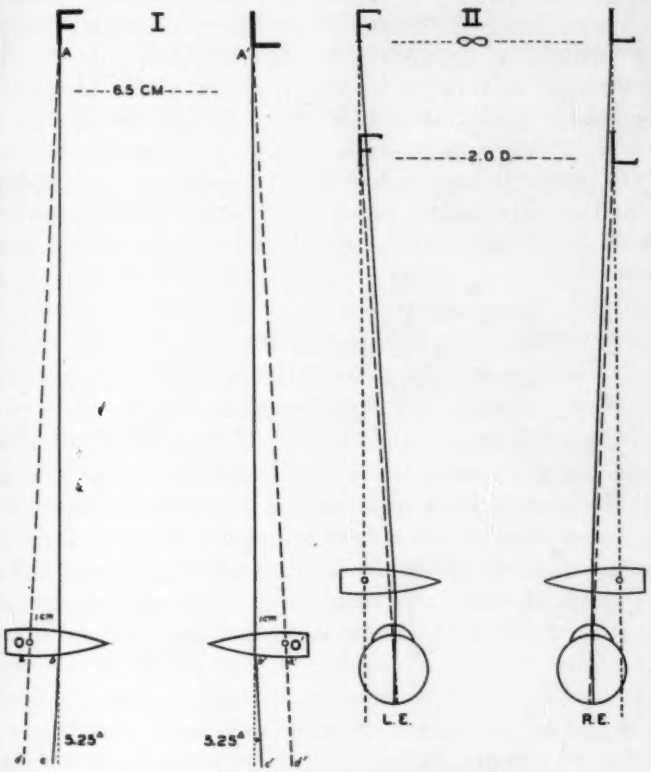

Chart 6.—I, the prismatic effect caused by the difference in the horizontal separation of patterns (AA') and lenses (OO'). The prismatic effect (the divergent direction of the two pencils of light *abcd* and *a'b'c'd'* emerging from the lenses) depends only on this difference and is the same for a pair of eyes with any pupillary distance, as it is not due to the difference between the horizontal separation of the lenses and the usual pupillary distance. *II*, the lines of fixation of the two eyes when looking at two stereoscopic patterns set (1) at the point of infinity or (2) at the distance requiring 2.00 D. of accommodation. In the first case the lines of fixation of the two eyes have to be parallel and no fusion movements are required if the patient has orthophoria. In the second example no convergence is possible in spite of the required 2.00 D. of accommodation if the two patterns are to be fused.

the slide holder is drawn toward the eyepiece. This stimulates the accommodation and with it the convergence.

Maddox published a table which gives the proper separation of the stereoscopic charts for squints. I have found it much simpler, however, to make the calculation for the necessary values than to look up a table not always at hand. It has just been shown that each centimeter of difference between the separation of the stereograms and the lenses necessitates 5.25 prism diopters of convergence, if the power of the lenses is +5.25 D. Vice versa, if a patient has an esophoria of 5.25 prism diopters, he can fuse a stereogram 8.5 — 1.0 = 7.5 cm. separation most easily. In general, if the exophoria (esophoria) is x prism diopters, the separation of the patterns has to be $\frac{x}{5.25}$ cm. more (less) than the separation of the centers of the lenses to attain superposition of the patterns without fusion movements. But even this calculation is superfluous if the patient is made to look at the B_3 chart with the slide holder set at infinity. The patient himself will say at what separation the exercises should be performed in order to increase his fusional amplitude (e. g., with the H and I series of Wells) with relaxed accommodation. Aside from this, the calculation is valid only for the point of infinity (i. e., with no accommodation). Moreover, it has been seen that with the B_3 chart it is possible to find the proper separation of charts for exercises with any desired amount of accommodation, so that the B_3 chart is just as accurate as and is simpler and more useful than the table by Maddox.

There is one more point that limits the usefulness of any calculation. The charts for exercises to combat suppression (e. g., the F and G series of Wells) unfortunately have a fixed separation of 6 cm., so that if it is desired to use them, no calculation is of any use. It must be ascertained by means of the B_3 chart at which setting of the slide holder its lines cross at 6. A patient with exophoria, orthophoria or esophoria of less than 13.12 prism diopters (according to calculations in the preceding paragraph) will have to accommodate in order to cross the lines at 6. This means that he will have to draw the slide holder nearer to the eyepiece so that his accommodation will help to bring about the necessary convergence. A patient with about 13 prism diopters of esophoria will see the two lines of the B_3 chart cross at 6 if and when the slide holder is at the point of infinity. A patient with more than 13 prism diopters of esophoria will not be able to set the B_3 chart at 6 without the help of prisms. Such a patient tries to fuse a stereogram of 6 cm. separation without auxiliary prisms by pushing the slide holder beyond the point of infinity. He has a latent hyperopia, and such an exercise relaxes his accommodation. It thus helps to uncover the latent hyperopia of a patient of this type. Others make a divergence effort, which is useful, in order

to fuse the two patterns of the stereoscope. In a case of very high esophoria or poor fusional amplitude, this will not be feasible, and it will be necessary to put as many auxiliary prisms, base out, into the prism holder of the stereoscope as will make the patients see the lines of the B_3 chart cross at 6.

MEASUREMENT OF HETEROPHORIA WITH THE AID OF THE B_3 CHART OF WELLS

The value of the B_3 chart in indicating the condition of muscular balance has already been discussed, and it has been mentioned that patients with exophoria will see the two lines cross farther to the right and patients with esophoria farther to the left. More accurate data on phorias may, however, also be obtained if the optical properties of the stereoscope are known.

Consider again a case in which the B_3 chart is in the slide holder at the anterior focal plane (the point of infinity) of the stereoscope. Assume that the optical separation of the lenses is, as is the case with the types generally used, 8.5 cm. and the power of the lenses + 5.25 D.; thus the anterior focal plane will be 19 cm. in front of the lenses. With the chart in the focal plane the rays will be so refracted that those originating from any one point of the chart will emerge in a pencil containing parallel rays (chart 2) from the right or the left lens. Since there are two lenses in a stereoscope, the direction of these pencils relative to each other must also be considered. It is shown in chart 2, *1* that two pencils originating, one on the right and the other on the left pattern, from points 8.5 cm. apart not only consist of parallel rays but are parallel with each other. Thus the rays originating on the horizontal line 8.5 cm. to the right of the vertical line will after emerging from the right lens assume exactly the same direction as do the rays originating from the vertical line after having emerged from the left lens.

If a person with orthophoria looks at the chart, his lines of fixation being parallel, he will necessarily see the vertical line crossing the horizontal at 8.5, since only the rays originating from the vertical line and from the point 8.5 cm. to the right on the horizontal can send two parallel pencils of rays into his eyes so as to strike the two maculas. This is a most accurate characteristic of orthophoria, and in general it may be said that if a person with orthophoria looks at the B_3 chart in a stereoscope of known optical separation and set at the point of infinity of the stereoscope, he must see the vertical line crossing the horizontal at exactly the same figure as that of the optical separation of the lenses in centimeters. Vice versa, if a person sees the lines of the B_3 chart crossing at a distance equal to the optical separation of the lenses, he must

be orthophoric.[10] A person with exophoria will see the intersection farther to the right (chart 2, *II*); one with esophoria, farther to the left (chart 2, *III*).

If it is known that the power of the lenses is +5.25 D., it is also known, from Prentice's rule, that pencils of rays coming from a point on the chart 1 cm. farther to the right have a deflection of 5.25 prism diopters; in other words, a person with an exophoria of 5.25 prism diopters will see the lines of the B_3 chart cross at a point 1 cm. farther to the right. Thus, if a patient looks into a stereoscope with + 5.25 D. lenses separated by 8.5 cm. and sees the lines of the B_3 chart crossing at 9.5, he must have $(9.5 - 8.5) \times 5.25 = 5.25$ prism diopters of exophoria. Similarly, if a patient sees the lines crossing, for instance, at 5, he must have $(8.5 - 5) \times 5.25 = 18.37$ prism diopters of esophoria (chart 2 *C*).

A basic rule may be stated as follows: An accurate measurement of phoria for distance is possible with the stereoscope and the B_3 chart of Wells (1) if the chart is set at the point of infinity in the stereoscope, (2) if the power of the ocular lenses is known and (3) if the separation of the optical centers is known.

The following points may be summarized:

1. In orthophoria the lines cross at the exact points on the scales the separation of which is identical with the separation of the optical centers of the lenses. If the lines cross to the right of this point (with larger figures), exophoria is present; if to the left, esophoria.

2. Each centimeter of deviation from this point indicates as many prism diopters of phoria as is the power of the lens in diopters.

3. In fusion exercises with the stereoscope at the point of infinity, 1 cm. of variation of the horizontal separation of the two patterns of a stereogram exerts as many prism diopters of fusional convergence (divergence) as is the power of the ocular lenses of the stereoscope in diopters.

EXERCISES WITH STEREOGRAMS OF FIXED SEPARATION AND MOVEMENT OF THE SLIDE HOLDER OF THE STEREOSCOPE

The problem raised by the use of stereograms with fixed separation may now be resumed. It has been seen that because most of the training stereograms have a certain fixed separation, their use should be limited to one setting of the slide holder, i. e., to one state of accommodation for every case. In most cases, however, it is desirable for the patient to perform exercises at the point of infinity, or with such different settings of accommodation as seem appropriate for the case.

There are three ways to accomplish this: 1. It is necessary to use stereograms with different horizontal separations (e. g., Dvorine's

10. This holds true whatever the pupillary distance may be (Maddox [7]).

charts [11]), and it can be ascertained with the B_3 charts which separation the charts should have for the desired setting of the accommodation. 2. Stereograms must be used with the two patterns on separate cards (e. g., the Sattler charts or some of the Keystone charts) that can be inserted into the stereoscope with any desired separation (a variable slide holder being most convenient). 3. If there are available only charts with a fixed separation (like the charts of Wells or Dahlfeld), it becomes necessary to move the slide holder together with the stereogram.

No problems are involved in the first two methods of performing stereoscopic exercises. They can be conducted properly and easily with the aid of the B_3 chart and are really the most advisable. The third method involves many problems.

It has been repeatedly emphasized in the foregoing pages that the slide holder should not be moved during the exercises. It is time, now, to give the reasons for this and to consider the question: What happens when a stereogram of fixed separation is observed in the stereoscope and the slide holder is moved?

Maddox gave the answer by mathematical analysis. His calculations, as already stated, proved that, contrary to the general belief, movement of the slide holder toward the eyepiece causes relative divergence and movement away from the eyepiece causes relative convergence. These calculations will be avoided, and what actually happens will be seen from a few examples.

If it is assumed that the two lenses of the stereoscope and the patterns of the stereogram have the same separation of 8.5 cm. (many of Keystone's excellent stereograms really have such a separation, thus avoiding the annoying dissociation of accommodation and convergence at the point of infinity, which in normal persons is caused by charts having a separation of 6 cm.), it is easy to realize that such a stereogram (chart 6, *II*), set at the point of infinity, will require no accommodation and that, in order for the patterns to be observed, the lines of fixation must be parallel, whether or not orthophoria is present. If, now, the patient draws the slide holder toward the eyepiece (chart 6, *II*), he will have to accommodate in order to see the picture clearly. No convergence, however, will be possible. The two lines of fixation will still have to be directed to points separated by 8.5 cm. in order to maintain single binocular vision. Thus the accommodative convergence will be counteracted by fusional divergence, and a state of relative divergence will be created.

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11. In this series (Animated Fusion Training Charts Co., Baltimore, 1933), there is a very good variation of the B charts of Javal-Wells, the questions of which can readily be answered also by very young children.

If a patient has 10 prism diopters of esophoria for distance vision, the B_3 chart, set at infinity, will show that he fuses without further effort charts of about 6.5 cm. of separation (this can also be found by calculation, without the B_3 chart, if the power and the optical separation of the lenses are known). If he draws the slide holder toward the eyepiece, he will accommodate but will still have to direct his lines of fixation to points of 6.5 cm. of separation. A state of relative divergence will again be created. If this patient has a greater amount of esophoria for near vision, such an exercise may be useful, as the excessive convergence accompanying his accommodation is counteracted. However, if a patient is orthophoric for distance vision and has 10 prism diopters of esophoria (convergence excess) for near vision only, it would be wrong to do such exercises with a chart having a separation of 6.5 cm. It would only encourage him to converge 10 prism diopters even for infinity. If the B_3 charts are used, this mistake will be avoided easily. The chart will indicate automatically that a patient with orthophoria for distance vision must use the charts with a separation of 8.5 cm. at the point of infinity. However, since the patient has a convergence excess for near vision (which equals esophoria during accommodation), it may be helpful to him to perform divergence exercises by drawing the charts of 8.5 cm. separation from the point of infinity toward the eyepiece. This will encourage relative divergence while accommodating.

One further example: If a patient while accommodating for 2.5 D. (i. e., with the slide holder set at 2.5 D.) sees the lines of the B_3 chart cross at 6, he fuses an ordinary stereogram at this setting without fusion movements. If the slide holder is pushed toward the point of infinity, the accommodation will relax, while the convergence will be allowed to change very little or not at all. Thus, such an exercise forces the patient to maintain convergence while relaxing accommodation. He can accomplish this only by using up fusional convergence reserve, provided he has some. The exercise does not, however, develop fusional convergence reserve if the patient has none.[12] Such an exercise may be helpful in the rare case of a divergence excess. It develops the faculty of relaxing accommodation without at the same time relaxing convergence. However, the usual condition observed, a slight amount of exophoria or none at all for distance vision and more for near, will not be helped by such an exercise. Such a patient's accommodation and convergence are already dissociated. He should learn to converge while accommodating, not while relaxing accommodation. The correct exercises for him are those

12. If the patient has poor fusional amplitudes he will simply get double images when he pushes the slide holder farther back.

with constant settings of the slide holder and decreasing separations of patterns, as previously described in this paper.

It will be seen that the exercises with a constant setting of the slide holder (which are advocated as those more valuable) have the tendency to produce the desirable coupling of accommodation and convergence. They may be called associative exercises, in contrast to those in which the slide holder is moved and it is attempted to break up, or dissociate, the relation of accommodation and convergence. With the latter exercises it is attempted to make the eyes diverge while accommodating or converge while relaxing the accommodation. These may be termed dissociative exercises. In the case of convergence or divergence excess they may be of value, but dissociation of accommodation and convergence are not the principal aim of orthoptic exercises. Aside from this, dissociative exercises can be performed only by patients who already have fusion faculty. A patient with amblyopia of one eye, suppression or low fusional amplitude should always perform the exercises with constant settings of the slide holder according to the directions of the B_3 chart. There is no need for calculation, and no mistakes are possible.

As to the value of the stereoscope, it is worth mentioning that even most of the "tricks" that it is alleged can be done only with the more elaborate instruments can be performed with the stereoscope. Practice is the best teacher. It is therefore not necessary to describe them in detail. One can, for instance, alternately cover and uncover one pattern with a piece of cardboard, use a simple flashlight for flashing in cases of amblyopia or make one picture less distinct by inserting tinted glass into a trial frame or into the prism holder of the stereoscope. These features can, of course, be accomplished more easily with the new elaborate instruments.

SUMMARY

In summarizing, it is again desired to emphasize that there are many orthoptic problems that can be solved satisfactorily with the simple stereoscope. There is no longer a question as to the value of orthoptic exercises, nor is there any reason why they should not be given by every ophthalmologist, since probably every practitioner is equipped with a stereoscope. I have therefore attempted to describe my method of giving orthoptic exercises at a time when the only instrument available to me was a stereoscope and to assure my readers that the results were entirely satisfactory.

INTERSTITIAL KERATITIS

ANALYSIS OF FIVE HUNDRED AND THIRTY-TWO CASES WITH PARTICULAR REFERENCE TO STANDARDIZATION OF TREATMENT

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Interstitial keratitis is a well known cause of impaired vision or blindness. Its importance may be seen from a previous study by the Cooperative Clinical Group,[1] which showed that interstitial keratitis is the most frequent disabling complication of congenital syphilis. This complication was found in approximately one third of 1,010 cases studied.

MATERIAL STUDIED

Patients.—The present study comprises an analysis of the records of 532 patients with interstitial keratitis who were treated or observed for at least one year. All of the patients had congenital syphilis. Although other aspects of interstitial keratitis were considered, the study was particularly concerned with the evaluation of various methods of antisyphilitic treatment in terms of the visual acuity of the patient at final examination.[2]

The material was made available by the syphilis clinics of the Western Reserve University, the Johns Hopkins University, the Mayo Clinic, the University of Pennsylvania and the Wills Eye Hospital, through members of the Cooperative Clinical Group, including Drs. Harold N. Cole, Joseph Earle Moore, Paul A. O'Leary, John H. Stokes and Joseph V. Klauder, and members of the United States Public Health Service, including Drs. Thomas Parran and R. A. Vonderlehr, Lida J. Usilton, M.A., and Eleanor Vandoren. This investigation was supported by a grant from the John and Mary R. Markle Foundation.

1. Cole, H. N.; Usilton, L. J.; Moore, J. E.; O'Leary, P. A.; Stokes, J. H.; Wile, U. J.; Parran, T., and Vonderlehr, R. A.: Late Prenatal Syphilis, with Special Reference to Interstitial Keratitis: Its Prevention and Treatment, Ven. Dis. Inform. **18**:97-111, 1937; Arch. Dermat. & Syph. **35**:563-579 (April) 1937.

2. Impairment of visual acuity is caused by changes in the cornea which are the direct result of interstitial keratitis. These corneal changes include opacities, deep blood vessels, folds in Descemet's membrane, precipitates, corneal dystrophy and changes in the curvature of the cornea which cause refractive errors.

Visual acuity was determined for some patients with refraction and for other patients without refraction. It is apparent from chart 1 (particularly with regard to patients whose interstitial keratitis was inactive) that for the majority of patients with uncorrected visual acuity refraction was not performed, either because visual acuity was so good that refraction was unnecessary or because visual acuity was so poor that refraction would have been of limited value. Apparently, then, a false picture of the efficacy of treatment would have been obtained if the study had been limited to patients with corrected visual acuity.

Controls.—An ideal control group would consist of patients selected at random with acute interstitial keratitis who were observed a year or more subsequent to admission but not treated. Since this was not

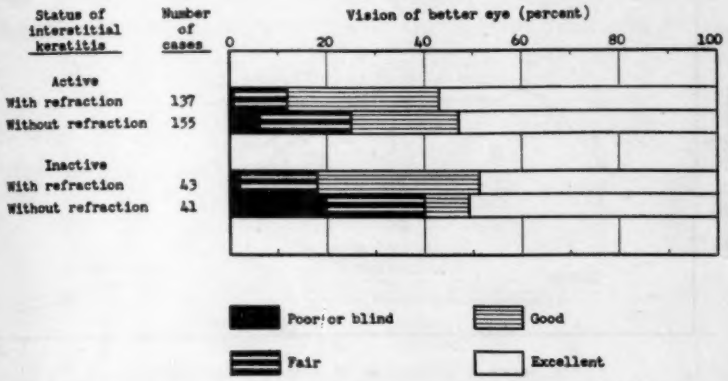

Chart 1.—Comparison of final vision determined with and without refraction of patients with active and with inactive interstitial keratitis.

possible, an alternative was suggested for obtaining an indication of visual acuity resulting in untreated interstitial keratitis. This was to select patients with bilateral inactive interstitial keratitis of at least a year's duration who had received little or no treatment. The control group thus devised consisted of 87 patients, none having received more than a total of six injections of an arsenical, a heavy metal or both. Visual acuity

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Other causes may be iridocyclitis, glaucoma, cataract and chorioretinitis. Impairment of visual acuity, therefore, may not necessarily connote a failure of antisyphilitic treatment. A more accurate evaluation of the results of such treatment is not visual acuity alone but a correlation of visual acuity with and without refraction and with results of slit lamp and ophthalmoscopic examinations. Patients with interstitial keratitis who also had cataract, glaucoma or primary or secondary atrophy of the optic nerve were excluded from the study so far as concerned evaluation of treatment.

was determined with refraction for 47 per cent and without refraction for 37 per cent. For the remaining 16 per cent there were no refraction data.

INCIDENCE

Race.—Seventy-three per cent of the patients were white and 27 per cent Negro.

Sex.—The majority of statistical studies of interstitial keratitis show a greater incidence in females. In this study approximately 60 per cent of the patients in each of the five cooperating clinics were females.

Age.—Chart 2 shows the age curves and the median age at onset of interstitial keratitis for 181 male and 304 female patients. In the females

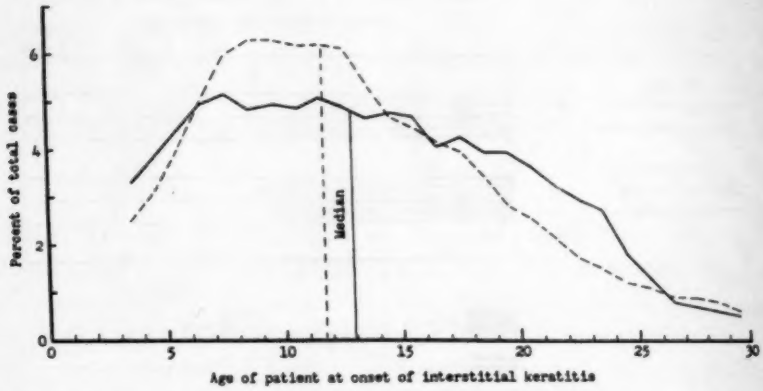

Chart 2.—Distribution of patients with interstitial keratitis by age at onset. The solid line indicates males (181); the dash line, females (304).

interstitial keratitis developed with the greatest frequency between the seventh and the thirteenth year, with 12 years as the median age at onset. In the males, although there was a slightly downward trend after about the seventh year, interstitial keratitis developed at a fairly constant rate from the fifth to the twentieth year. Of the 485 patients for whom the age at onset was known, in 13 interstitial keratitis developed before the age of 3 years and in 8 after the age of 30.

SEROLOGIC REACTIONS

The two factors which appear to have the greatest influence on the serologic reaction of the blood are previous treatment and status of interstitial keratitis.

As will be seen from chart 3, patients with inactive interstitial keratitis who had been treated had the highest percentage of negative reactions (30 per cent); the smallest number of negative reactions was observed in untreated patients with active interstitial keratitis (2.5 per cent). In the untreated group the reaction in patients with interstitial keratitis was found to be negative more than four times as frequently as in the patients with active interstitial keratitis (11.7 per cent to 2.5 per cent).

The age of the patient and the duration of interstitial keratitis also appeared to be influencing factors, but the higher percentage of positive reactions in the younger age groups and the shorter periods of duration seem to be accounted for by the preponderance of active interstitial keratitis in these groups.

The difference in the percentage of patients who had reversal of serologic reactions following different amounts of treatment was not

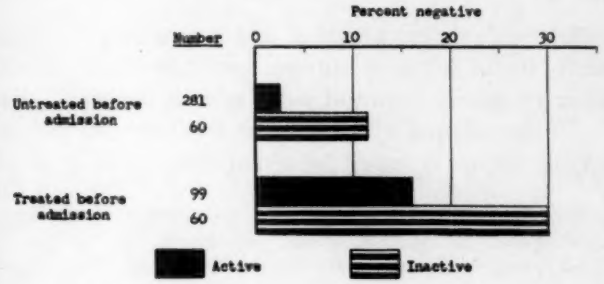

Chart 3.—Comparison of the percentages of negative reactions of the blood in treated and in untreated patients with the status of interstitial keratitis on admission.

great. A difference, however, was noted in the different age groups. Forty-six per cent of the patients had reversal of serologic reactions to negative in the age group 0 to 9 years, compared with 22 per cent in the age group 10 to 19 and with 17 per cent in the age group 20 to 29.

OTHER SYPHILITIC MANIFESTATIONS

Table 1 shows the relative frequency with which concomitant syphilitic manifestations occurred in 532 patients. Those most frequently observed were as follows: Hutchinson teeth, 40 per cent; bone and joint involvement (as enumerated in the table), 35 per cent; labyrinthine disease, 10 per cent; chorioretinitis,[3] 8 per cent, and neurosyphilis (symptomatic and asymptomatic), 8 per cent.

3. Chorioretinitis was not separated into the different types as classified by Sidler-Huguenin (Ueber die hereditär syphilitischen Augenhintergrundveränder-

(Footnote continued on next page)

Bone and joint involvement and also neurosyphilis were observed with greater frequency in the males than in the females. Involvement of bones and joints, chorioretinitis and symptomatic neurosyphilis were more common in the white race than in the Negro. The difference in the incidence of chorioretinitis may be explained by the fact that the fundi were examined in 50 per cent of the white patients and in 30 per cent of the Negroes. The observation of a greater incidence of bone and joint involvement, of chorioretinitis and of symptomatic neurosyphilis is consistent, however, with the observations of the Cooperative Clinical Group,[1] in which it was observed that congential syphilis ran a stormier course in white than in Negro patients.

Involvement of the eighth nerve, long associated with interstitial keratitis since Hutchinson included it in his well known triad, was present in 10 per cent of the 532 patients in this study but in only 6 per cent of the 1,010 patients comprising the group with congenital syphilis.[1]

Neurosyphilis, both symptomatic and asymptomatic, was observed less frequently in the group of patients with interstitial keratitis (8 per cent) than in the entire group of patients with congenital syphilis (14 per cent). Of the patients with asymptomatic neurosyphilis, the majority showed the group II type[4] of spinal fluid. The spinal fluid was

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ungen nebst einigen allgemeinen Bemerkungen über Augenerkrankungen bei angeborener Lues, Beitr. z. Augenh., 1902, no. 51, p. 1). These four types characteristically involve the periphery of the fundi and appear early in congenital syphilis, invariably antedating interstitial keratitis. Chorioretinitis, on the other hand, may appear with interstitial keratitis associated with uveitis. The incidence of chorioretinitis in patients with interstitial keratitis as reported by different writers varies considerably. Dalsgaard-Nielson gives the incidence as 16 per cent (Dalsgaard-Nielson, E.: On "Recurrence" of Syphilitic Interstitial Keratitis, Acta ophth. **17**:43, 1939); Derby as 55 per cent (Derby, G. S.: Ophthalmic Notes from Base Hospital No. 5, U. S. Army No. 11, General Hospital, B. E. F., France, Ophth. Rec. **26**:536, 1917); Cunningham as 68 per cent (Cunningham, J. F.: The Analysis of a Series of Cases of Interstitial Keratitis, Tr. Ophth. Soc. U. Kingdom **42**:44, 1922); Spicer as 29 per cent (Spicer, W. T. H.: Parenchymatous Keratitis: Interstitial Keratitis; Uveitis Anterior, British Journal of Ophthalmology Monograph Supplement 1, London, George Pulman & Sons, Ltd., 1924), and Igersheimer as 36 per cent (Igersheimer, J.: Syphilis und Auge, in Jadassohn, J.: Handbuch der Haut- und Geschlechtskrankheiten, Berlin, Julius Springer, 1928, vol. 17, p. 152). Ophthalmoscopic examination to demonstrate old chorioretinitis in the periphery of the fundi and slit lamp microscopy to demonstrate the sequelae of interstitial keratitis are valuable aids in the diagnosis of congenital syphilis at any age.

4. Group II type (moderate): spinal fluid in which the cell count and globulin content are increased, the Wassermann reaction is positive or weakly positive and the results of colloidal gold tests are indeterminate or positive; if the last-mentioned tests are positive, the spinal fluid is usually of the syphilitic zone type.

TABLE 1.—*Incidence of Associated Syphilitic Involvements According to Race and Sex in Patients with Interstitial Keratitis*

Associated Syphilitic Involvements	White						Colored						Total					
	Male		Female		Total		Male		Female		Total		Male		Female		Total	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Teeth	61	41.8	98	40.3	159	40.9	18	34.6	36	39.6	54	37.8	79	39.9	134	40.1	213	40.0
Bone and joint disease	68	46.6	81	33.3	149	38.3	18	34.6	21	23.1	39	27.3	86	43.4	102	30.5	188	35.3
Fournier's tibia	38	26.0	39	16.0	77	19.8	7	13.5	4	4.4	11	7.7	45	22.7	43	12.9	88	16.5
Clutton's joints	13	8.9	19	7.8	32	8.2	9	17.3	9	9.9	18	12.6	22	11.1	28	8.4	50	9.4
Prominent frontal bossae	14	9.6	16	6.6	30	7.7	1	1.9	3	3.3	4	2.8	15	7.6	19	5.7	34	6.4
Saddle nose	10	6.8	8	3.3	18	4.6	1	1.9	2	2.2	3	2.1	11	5.6	10	3.0	21	3.9
Other and unspecified	9	6.2	18	7.4	27	6.9	3	5.8	4	4.4	7	4.9	12	6.1	22	6.6	34	6.4
Labyrinthine disease	10	6.8	22	9.1	32	8.2	4	7.7	17	18.7	21	14.7	14	7.1	39	11.7	53	10.0
Chorioretinitis	11	7.5	27	11.1	38	9.8	..	....	4	4.4	4	2.8	11	5.6	31	9.3	42	7.9
Central nervous system	20	13.7	15	6.2	35	9.0	3	5.8	3	3.3	6	4.2	23	11.6	18	5.4	41	7.7
Asymptomatic	9	6.2	8	3.3	17	4.4	3	5.8	2	2.2	5	3.5	12	6.1	10	3.0	22	4.1
Asymptomatic (cerebrospinal fluid: negative syphilitic reaction)	7	4.8	3	1.2	10	2.6	..	....	1	1.1	1	0.7	7	3.5	4	1.2	11	2.1
Asymptomatic (cerebrospinal fluid: positive syphilitic reaction)	4	2.7	4	1.6	8	2.1	..	....	..	....	..	....	4	2.0	4	1.2	8	1.5
Skin and mucous membrane	5	3.4	13	5.3	18	4.6	1	1.9	4	4.4	5	3.5	6	3.0	17	5.1	23	4.3
Visceral disease	6	4.1	8	3.3	14	3.6	1	1.9	1	1.1	2	1.4	7	3.5	9	2.7	16	3.0
Cranial nerves (except the eighth)	1	0.7	4	1.6	5	1.3	..	....	1	1.1	1	0.7	1	0.5	5	1.5	6	1.1
None	35	24.0	82	33.7	117	30.1	16	30.8	33	36.3	49	34.3	51	25.8	115	34.4	166	31.2
More than one	48	32.9	76	31.3	124	31.9	9	17.3	20	22.0	29	20.3	57	28.8	96	28.7	153	28.8
Total patients	146		243		389		52		91		143		198		334		532	

normal in the majority of patients in the symptomatic group. In this group vascular neurosyphilis and tabes were the two principal diagnoses. There were two patients with dementia paralytica, 1 of them with the tabetic form, and each had the group III type of spinal fluid. Igersheimer [5] mentioned the rarity of either primary atrophy of the optic nerve or ocular motor paralysis in association with interstitial keratitis. Kopp and Solomon [6] stressed the relative infrequency of interstitial keratitis as a concomitant of congenital neurosyphilis, especially juvenile dementia paralytica. In this regard, it is to be noted that only 0.4 per cent of the patients in this series had dementia paralytica, including the tabetic form, compared with 4.6 per cent in the entire group of patients with congenital syphilis.[1]

STATUS AND DURATION OF INTERSTITIAL KERATITIS

The status of interstitial keratitis in 532 patients on admission is given in table 2.

TABLE 2.—*Interstitial Keratitis in Five Hundred and Thirty-Two Patients*

	Number	Per Cent
Unilateral involvement		
Active *	151	28.4
Inactive *	17	3.2
Bilateral involvement		
Active, one eye	28	5.3
Active, both eyes	223	41.9
Inactive, both eyes	113	21.2

* As used in this paper, the term active refers to the presence, in variable degrees, of the following symptoms of inflammation: pericorneal congestion, increased lacrimation, photophobia and evidence of uveitis. Associated with these symptoms are a hazy cornea and opacities. The term inactive refers to the absence of these symptoms. In this stage there are corneal opacities or the cornea is clear on gross examination.

The duration on admission was less than three months for 89 per cent of 151 patients with active unilateral interstitial keratitis, less than two weeks for 13 per cent, two to six weeks for 57 per cent and more than six weeks for the balance.

Group III type (severe); spinal fluid which shows the so-called dementia paralytica formula, i. e., marked excess of globulin, strongly positive Wassermann reaction (with 0.2 cc. or less) and the dementia paralytica type of colloidal gold curves; the cell count is above normal and contains, in addition to small lymphocytes, large lymphocytes and polymorphonuclear leukocytes.

5. Igersheimer, J.: Syphilis und Auge, in Jadassohn, J.: Handbuch der Haut- und Geschlechtskrankheiten, Berlin, Julius Springer, 1928, vol. 17, p. 152.

6. Kopp, I., and Solomon, H. C.: Interstitial Keratitis in Patients with Neurosyphilis of Congenital Origin, with a Discussion of Fever as a Precipitating Factor of Keratitis in the Paretic Variety, Am. J. Syph., Gonor. & Ven. Dis. **23**:751-758, 1939.

Sixty per cent of 223 patients with active bilateral interstitial keratitis had had the condition for less than three months. The duration ranged from one to six weeks for 34 per cent. For 15 per cent the duration was more than a year. No distinction was made between first attack of interstitial keratitis and recurrence. This accounts for the fairly high percentage of patients with active interstitial keratitis of more than one year's duration.

TREATMENT EMPLOYED IN STUDY [7]

Arsenicals and Heavy Metals.—The administration of an arsenical in conjunction with a heavy metal constituted the routine therapy. Among the arsenicals employed, neoarsphenamine and old arsphenamine predominated. In order of decreasing frequency of use, the other arsenicals were silver arsphenamine, sulfarsphenamine, mapharsen, bismarsen and tryparsamide. The heavy metals used were bismuth subsalicylate and mercury.

Of the 532 patients, 97 per cent were treated with an arsenical, practically all in conjunction with a heavy metal. Bismuth was more popular than mercury. Patients with active interstitial keratitis, whose final visual acuity was tabulated by amount of treatment, received a median of twenty-eight injections of an arsenical and fifty-one injections of a heavy metal (or weeks of mercury inunctions); those with inactive interstitial keratitis, a median of twenty-one injections of an arsenical and forty-four injections of a heavy metal. One fourth of the patients with active interstitial keratitis received as much as eighty injections of either bismuth subsalicylate or mercury, and only 7 per cent received less than twenty injections of a heavy metal and less than twenty injections of an arsenical.

Iodides.—Most of the 290 patients given iodides received potassium iodide orally. The dose ranged from 30 to 270 grains (2 to 17.5 Gm.) daily. Sixteen patients were treated with sodium iodide intravenously, in doses of 2 to 10 grains (0.13 to 0.65 Gm.) per injection, the total number of injections varying from three to thirty-one.

Fever Therapy.—This embraced induced malaria therapy, with an average of ten fever bouts, mechanically induced fever, with an average of eight to nine bouts of four to five hours, intramuscular injections of sterile milk and intravenous injection of vaccines (typhoid, antigen H [8] and pyrifer [9]). Typhoid was the most common form of fever therapy given to the 127 patients.

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7. The patients were treated prior to clinical experimentation with riboflavin for interstitial keratitis.

8. Antigen H is the flagellated portion of the typhoid bacillus.

9. Pyrifer is a Swiss preparation, a nonspecific protein mixture prepared with extracts of fever-producing colon bacilli of nonpathogenic stocks.

Local Heat Therapy.—The thermophore[10] was employed in one clinic in an endeavor to heat the cornea to the thermal death point of Spirochaeta pallida. The uninvolved eye was treated in the hope of preventing involvement; the involved eye, in order to determine if heat locally applied was of benefit in the treatment of interstitial keratitis. After clinical use and after experimental studies,[11] it was apparent that these purposes were not achieved. The use of the thermophore in the treatment of interstitial keratitis was, therefore, discontinued.

INTERVAL BETWEEN INVOLVEMENT OF FIRST EYE AND THAT OF SECOND EYE

An attempt was made to ascertain the influence of treatment in preventing unilateral interstitial keratitis to the other eye.[12] It was impossible to determine the effect of treatment subsequent to admission, largely because of the short interval elapsing between the involvement first of one and then of the other eye in the majority of cases. A reduction in the probability of involvement of the other eye, although not a significant one, was found among patients who had previous treatment.

With reference to the axiom that interstitial keratitis inevitably becomes bilateral,[13] it appeared that the chance of escaping bilateral involvement increases in direct ratio to the lapse of time from the onset of interstitial keratitis in the first eye. This may be seen in table 3, which shows the intervals between involvement of the two eyes in treated

10. The thermophore is an instrument employed by ophthalmologists for heat therapy of pathologic lesions in the cornea. After local anesthesia, the thermophore was applied to the cornea for one minute at variable temperatures, ranging from 120 to 128 F. (48.9 to 53.3 C.), three times weekly for twelve to fifteen consecutive treatments.

11. The measurement of the degree of penetration of heat applied to the anterior surface of the cornea of rabbits, the maximum temperature the cornea of man can tolerate with safety and the time required to kill S. pallida when heated at 120 F. (48.9 C.) are discussed in the paper "Clinical and Experimental Studies of Interstitial Keratitis" (Klauder, J. V.; Gross. E. R., and Robertson, H. F.: J. Invest. Dermat. **2**:157-173, 1939).

12. There are several theories of the mechanism that motivates the onset of interstitial keratitis and the involvement of the second eye. The simplest explanation of second eye involvement is that it is an expression of elective or paired organ sensitization. This concept envisages similar organs with a common trophonervous influence as a closed entity with a common inflammatory reaction. This concept could also serve to explain other paired organ involvement in patients with congenital syphilis, such as deafness and symmetric serous synovitis.

13. Stokes, J. H.: Modern Clinical Syphilology, ed. 2, Philadelphia, W. B. Saunders Company, 1934, p. 1243.

and in untreated patients from whom this information was available, either through clinical observation or from the patients' statements. Of the 355 observed for two years, 42 per cent experienced involvement of the second eye within one month after that of the first, and 29 per cent more had bilateral involvement at intervals ranging up to two years. Of the patients observed ten years or more, only 8 per cent more had involvement which had become bilateral. This left 21 per cent whose condition had remained unilateral for more than ten years.

A study confined to 151 patients with diagnoses on admission of active and unilateral interstitial keratitis supported this observation. The interstitial keratitis remained unilateral throughout observation (one year or more) in 33 per cent of the patients with interstitial keratitis of

TABLE 3.—*Length of Time for Interstitial Keratitis to Become Bilateral After Involvement of First Eye*

Length of Time	Total Patients Observed	Patients with Bilateral Involvement	
		Number	Per Cent
1 month	355	149	42.0
2 months	355	182	51.3
3 months	355	193	54.4
4 months	355	206	58.0
5 months	355	210	59.2
6 months	355	215	60.6
1 year	355	237	66.8
2 years	355	252	71.0
3 years	313	227	72.5
4 years	245	176	71.8
5 years	211	153	72.5
10 years	172	135	78.5
Over 10 years	67	53	79.1

less than one month's duration, compared with 51 per cent of the patients in whom the duration was one to two months.

Of the 151 patients, 96 had had no previous treatment. Investigation of the latter group showed that the increased chance from the first to the second month of escaping involvement of the other eye was not due to treatment. Among the untreated patients the involvement remained unilateral in 28 per cent of those with disease of less than one month's duration and in 50 per cent of those with disease of one to two months' duration.

The relation of the active stage of interstitial keratitis to the chance of involvement of the other eye was determined by comparing the 151 patients with 17 who had interstitial keratitis which was unilateral but inactive on admission. The majority in both groups were untreated previous to admission, but all were treated afterward. In 71 per cent

of the patients with inactive unilateral interstitial keratitis the disease remained unilateral, compared with only 40 per cent in which the disease was active on the patient's admission.

EFFECT OF ROUTINE TREATMENT ON VISUAL ACUITY

Visual acuity was interpreted in this study in the following way:

Excellent: 6/6 (20/20); 6/9 (20/30)

Good: 6/12 (20/40); 6/15 (20/50)

Fair (practical): 6/21 (20/70); 6/30 (20/100); 6/60 (20/200)

Poor: Less than 6/60 (20/200)

Blind: Perception of hand movements, perception of light; inability of patient to go about unattended

The visual acuity on admission and on final examination of 271 eyes of patients treated in the active stage of interstitial keratitis and of 115 eyes of patients treated in the inactive stage is shown in chart 4. It appears that treatment administered in the inactive stage of interstitial keratitis is of limited value in improving visual acuity. The visual acuity on admission was poor or nil in 19 per cent of eyes of patients treated in the inactive stage of interstitial keratitis, compared with 22 per cent on final examination. On the other hand, the visual acuity on admission was poor or nil in 55 per cent of eyes of patients treated in the active stage of the disease, compared with 11 per cent on final examination. The improvement of visual acuity represented in the difference between 55 and 11 per cent cannot be credited entirely to the effect of treatment, since after the subsidence of acute inflammatory symptoms of interstitial keratitis, in the absence of treatment, improvement of visual acuity occurs.

Active Interstitial Keratitis.—Chart 5 stresses the value of treating patients with active interstitial keratitis with twenty or more injections of an arsenical plus heavy metal. On final examination visual acuity was excellent in 37 per cent of 183 eyes of patients treated with twenty injections or more and in 27 per cent of 88 eyes of patients treated with less than twenty injections. In patients treated with more than twenty injections the percentage of eyes with excellent visual acuity was 7 on admission and increased to 37, showing a difference of 30 per cent, whereas in patients treated with less than twenty injections the increase was from 14 to 27 per cent, a difference of 13 per cent.

Fifty-seven per cent of 183 eyes of patients receiving this minimum treatment had poor visual acuity on admission, compared with 9 per cent on final examination, showing a difference of 48 per cent. Fifty per cent of 88 eyes of patients treated with less than this amount had

poor visual acuity on admission, compared with 14 per cent on final examination, showing a difference of 36 per cent.

The importance of employing at least twenty injections of an arsenical with interim heavy metal in treatment of interstitial keratitis in the

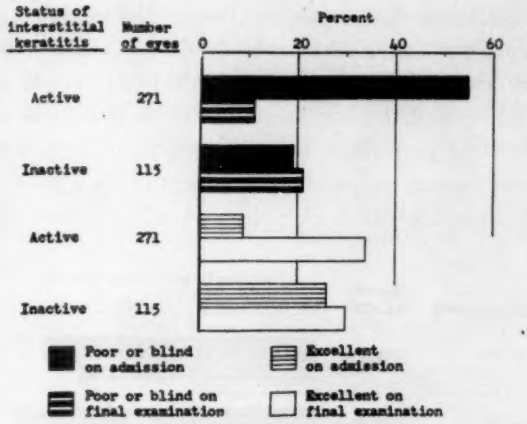

Chart 4.—Comparison of visual acuity on admission with final visual acuity of patients with active and with inactive interstitial keratitis.

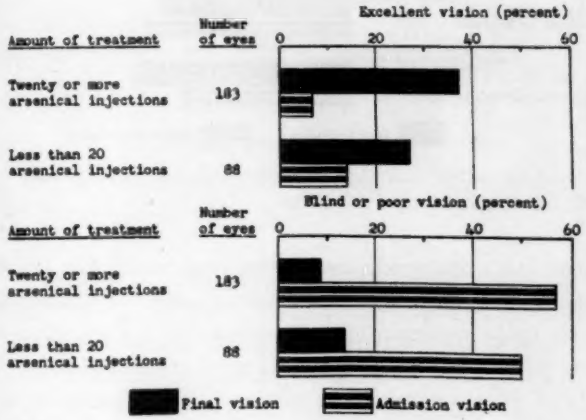

Chart 5.—Comparative values of different amounts of arsenical treatment for patients with active interstitial keratitis.

active stage is emphasized once more. This phase in therapy of the disease was stressed in Cole's study.[1]

Inactive Interstitial Keratitis.—Chart 6 is made from observations on a series of patients with inactive interstitial keratitis. The visual

acuity of these patients on admission, calculated on a total of 115 eyes, was excellent in 26 per cent. The chart shows the influence of twenty or more injections of an arsenical (plus heavy metal) and of less than twenty injections on the visual acuity of patients at final examination. The increase in excellent vision was the same for patients treated with the smaller and with the larger amounts. The change in both groups was slight (3.5 per cent) and probably due to visual refraction rather than to treatment. More than twenty injections caused a 1.5 per cent decrease in the eyes with poor visual acuity or blindness after treatment compared with the percentage before treatment. With less than twenty injections there was an increase of 5 per cent in the eyes with poor visual acuity or blindness compared with the percentage before treatment.

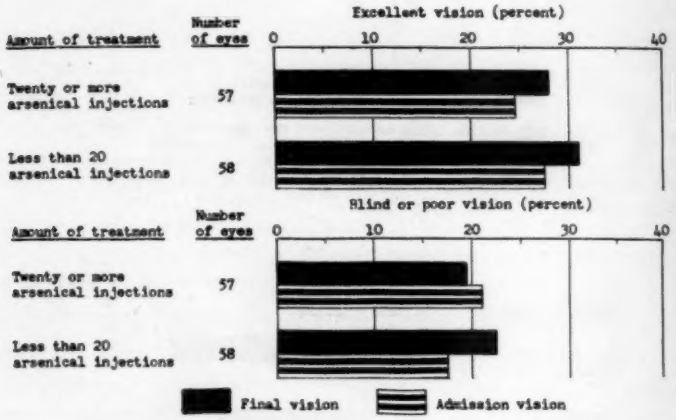

Chart 6.—Comparative values of different amounts of arsenical treatment for patients with inactive interstitial keratitis.

Consistent with the conclusion drawn from chart 4 is the observation that treatment administered in the inactive stage of interstitial keratitis is of limited value in improving visual acuity. This seemed to apply whether the patient had or had not received treatment prior to the time the interstitial keratitis became inactive. The importance of diagnosis and treatment of interstitial keratitis while still active is apparent.

EFFECT OF TREATMENT WITH FEVER AND WITH IODIDES

Active Stage.—In chart 7 (which includes observations only on patients with determinations of visual acuity both on admission and on final examination) a comparison is made of the effectiveness of different plans of therapy in treatment of patients with interstitial keratitis in the

active stage. This chart is based on observations on a total of 271 eyes. The percentage of eyes of patients with poor visual acuity or blindness on admission is compared with the percentage having excellent visual acuity on final examination, after different plans of therapy. Best results were obtained in patients receiving routine treatment only and routine treatment plus fever therapy. Forty-four per cent of the eyes of patients receiving these two types of treatment had excellent visual acuity on final examination. The percentage of eyes with poor visual acuity before treatment was greater in patients receiving routine treatment plus fever therapy than in patients who were treated with any one of the other plans of therapy.

The percentage of eyes with excellent visual acuity on final examination after routine treatment with the addition of iodides was 29;

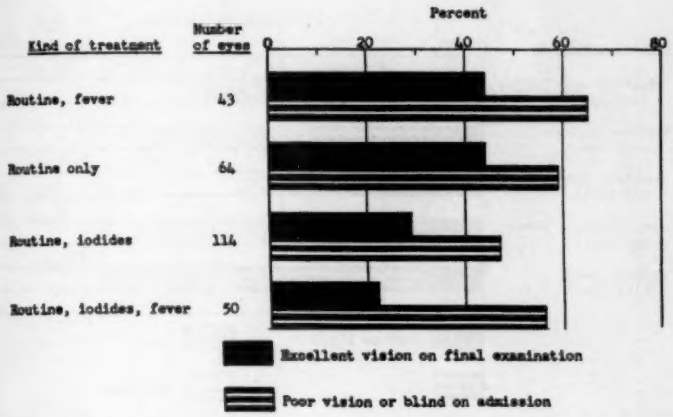

Chart 7.—Comparative values of different plans of treatment for patients with active interstitial keratitis.

after routine treatment with the addition of iodides and fever therapy the percentage was 22. These poor results cannot be attributed to "last resort" treatment, since the latter two plans of therapy were undertaken as a matter of choice in the majority of cases.

Chart 8 and table 4 (based on observations on patients with a final visual acuity examination) show the percentage of eyes with excellent visual acuity on final examination, as well as the percentage with good, fair and poor visual acuity, following different plans of therapy. Visual acuity of untreated patients comprising the control group is also shown. Fifty-one per cent of the eyes of patients given routine treatment plus fever therapy had excellent visual acuity on final examination, and 18 per cent had good visual acuity. The percentage of patients having

excellent visual acuity was significantly greater than that of patients given routine therapy plus iodides or plus iodides and fever therapy. The percentage of eyes with excellent visual acuity on final examination following routine treatment only was 44; following routine treatment with the addition of iodides, 34, and following routine treatment with the addition of iodides and fever therapy, 31.

Comparison of the results in the group receiving the best treatment (routine plus fever therapy) with those in the control group, as shown in chart 8, discloses the following percentage distribution in final visual acuity:

	Excellent	Good	Fair	Poor or Blind
Group receiving the best treatment.....	51	17	23	10
Untreated group.....	24	27	37	12

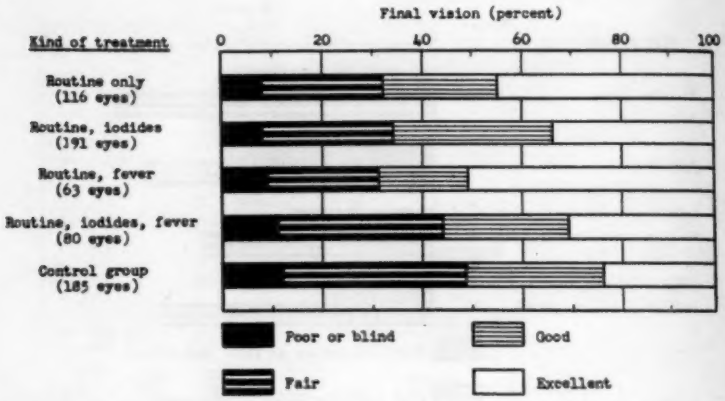

Chart 8.—Comparison of the final visual acuity of patients with active interstitial keratitis following different plans of treatment with the final visual acuity of the control group.

The greatest variation in the proportion of patients with poor visual acuity following the different plans of treatment was only from 8 to 11 per cent. Apparently, then, the superiority of one plan over another involves an increase in the proportion of patients with excellent vision following treatment and not a decrease in the proportion whose sight remained poor.

Inactive Stage.—The data in this study did not indicate that iodides were beneficial in the treatment of inactive interstitial keratitis. Of 34 eyes of patients who were treated routinely with iodides, 21 per cent had excellent visual acuity on admission, compared with 35 per cent on final examination. In 72 eyes of patients treated with iodides routinely, the comparison was 26 to 29 per cent. In comparing the percentage of

TABLE 4.—*Visual Acuity of Patients After Various Kinds of Therapy Compared with Visual Acuity of Control Group (Based on Total Number of Eyes)*

Visual Acuity	Controls		Patients with Active Interstitial Keratitis on Beginning Treatment										Patients with Inactive Interstitial Keratitis on Beginning Treatment					
			After Routine Therapy		After Routine and Fever Therapy		After Routine Therapy and Iodides		After Routine Iodides and Fever Therapy		Total		After Routine Therapy		After Routine Therapy and Iodides		Total	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
6/ 6	22	11.9	33	28.4	20	31.7	34	17.8	12	15.0	99	22.0	15	23.8	15	14.3	30	17.9
6/ 9	23	12.4	19	16.4	12	19.0	31	16.2	13	16.3	75	16.7	11	17.5	16	15.2	27	16.1
6/12	24	13.0	13	11.2	3	4.8	27	14.1	8	10.0	51	11.3	5	7.9	9	8.6	14	8.3
6/15	26	14.1	14	12.1	8	12.7	35	18.3	12	15.0	69	15.3	9	14.3	14	13.3	23	13.7
6/21	18	9.7	13	11.2	7	11.1	20	10.5	10	12.5	50	11.1	2	3.2	10	9.5	12	7.1
6/30	29	15.7	9	7.8	5	7.9	10	5.2	7	8.8	31	6.9	1	1.6	9	8.6	10	6.0
6/60	21	11.4	6	5.2	2	3.2	19	9.9	9	11.3	36	8.0	7	11.1	9	8.6	16	9.5
—6/60	16	8.6	6	5.2	4	6.3	11	5.8	4	5.0	25	5.6	5	7.9	13	12.4	18	10.7
Blindness	6	3.2	3	2.6	2	3.2	4	2.1	5	6.3	14	3.1	8	12.7	10	9.5	18	10.7
Total	185	100.0	116	100.0	63	100.0	191	100.0	80	100.0	450	100.0	63	100.0	105	100.0	168	100.0
Excellent	45	24.3	52	44.8	32	50.8	65	34.0	25	31.3	174	38.7	26	41.3	31	29.5	57	33.9
Good	50	27.0	27	23.3	11	17.4	62	32.5	20	25.0	120	26.7	14	22.2	23	21.9	37	22.0
Fair	68	36.8	28	24.1	14	22.2	49	25.7	26	32.5	117	26.0	10	15.9	28	26.7	38	22.6
Poor or blindness	22	11.9	9	7.8	6	9.5	15	7.9	9	11.3	39	8.7	13	20.6	23	21.9	36	21.4

patients having poor visual acuity on admission with that on final examination, a 6 per cent decrease was noted in patients treated routinely without iodides and a 7 per cent increase in patients treated routinely with iodides.

The study of Cole and co-workers [1] showed that iodides exert a harmful influence in the treatment of active interstitial keratitis, but the authors recognized them to be of value for chronic interstitial keratitis. Although they have been long recommended, the present study reveals that there is no apparent justification for the continued use of iodides, either orally or intravenously, in active or inactive interstitial keratitis.

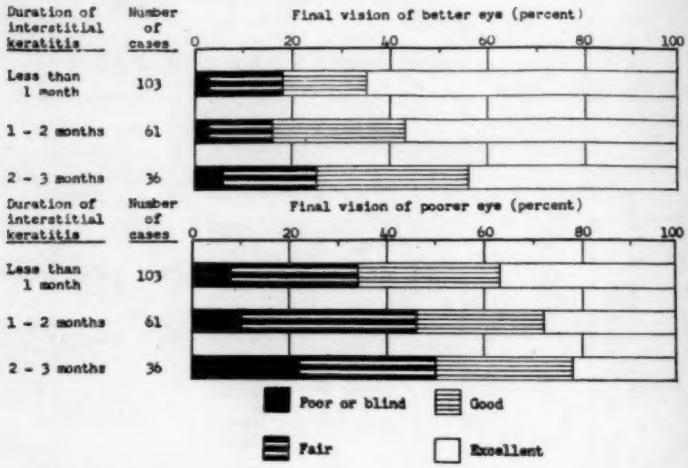

Chart 9.—Final visual acuity in relation to the duration of interstitial keratitis at the onset of treatment.

EFFECT OF TREATMENT

Duration.—Chart 9 shows visual acuity at final examination of 200 patients with active interstitial keratitis in relation to duration at onset of treatment. Patients treated within one month after the onset of interstitial keratitis had much better visual acuity on final examination than patients treated two to three months after onset and slightly better visual acuity than patients treated one to two months after onset of the disease. This applied to the visual acuity of the better eye as well as to that of the poorer eye.

Relapse.—The term relapse refers to a recurrence of inflammatory symptoms of interstitial keratitis in a given eye after previous inflammation has disappeared.

Table 5 includes only those relapses occurring one year or more after onset in 296 patients with early active interstitial keratitis on admission. Routine treatment supplemented with fever therapy was superior to other forms of therapy in preventing relapse. Of 55 patients given routine treatment plus fever therapy, only 1 had a relapse. It is to be noted, however, that fever therapy of this patient consisted of only two injections of typhoid vaccine. Relapses in groups of patients given other types of treatment were approximately the same, ranging from 13 to 18 per cent.

The number of arsenical injections also appeared to influence the percentage of relapses. Of 198 patients treated with less than twenty injections in the first year, 28, or 14 per cent, had a relapse of interstitial

TABLE 5.—*Relapses Occurring a Year or More After Onset of Interstitial Keratitis in Patients Receiving Various Kinds and Amounts of Treatment in the First Year*

Kind of Treatment Administered in First Year	Arsenical Treatment Administered in First Year								
	Less than Twenty Injections			Twenty or More Injections			Total		
		Patients with Relapses			Patients with Relapses			Patients with Relapses	
	Total Patients	Number	Per Cent	Total Patients	Number	Per Cent	Total Patients	Number	Per Cent
Routine only	72	11	15.3	27	2	7.4	99	13	13.1
Routine and iodides	76	11	14.5	28	4	14.3	104	15	14.4
Routine and fever	25	1*	4.0	30	..	....	55	1*	1.8
Routine, iodides and fever	25	5	20.0	13	2	15.4	38	7	18.4
Total	198	28	14.1	98	8	8.2	296	36	12.2

* Two injections of typhoid vaccine.

keratitis, compared with 8 per cent of 98 patients treated with more than this amount.

Continuous Versus Intermittent Treatment.—Chart 10 shows the effect, as judged at final examination, of continuous, intermittent or irregular treatment on visual acuity of the better eye, as well as of the poorer eye, of 376 patients. The visual acuity of untreated patients comprising the control group is also shown. Little difference is noted in the visual acuity of the better eyes of patients treated continuously, intermittently or irregularly. As far as final visual acuity of the poorer eye was concerned, continuous treatment was superior to intermittent or irregular treatment. Sixty-four per cent of the patients continuously treated had good or excellent visual acuity in both eyes, as compared with 47 and 48 per cent of patients treated intermittently or irregularly. A smaller amount of poor visual acuity or blindness was observed in patients treated continuously or intermittently than in those treated irregularly.

Comparison of Various Arsenicals.—It was not possible to determine the comparative effectiveness of the arsenicals employed, since most patients were not treated exclusively with one arsenical. A comparison of old arsphenamine and neoarsphenamine was possible. These drugs produced approximately the same percentage of excellent visual acuity.

Comparison of Various Agents Producing Fever Therapy.—Fever therapy was employed in conjunction with routine treatment, consisting of arsenicals and a heavy metal. The average number of fever bouts was eight. The average peak temperatures produced by the various agents

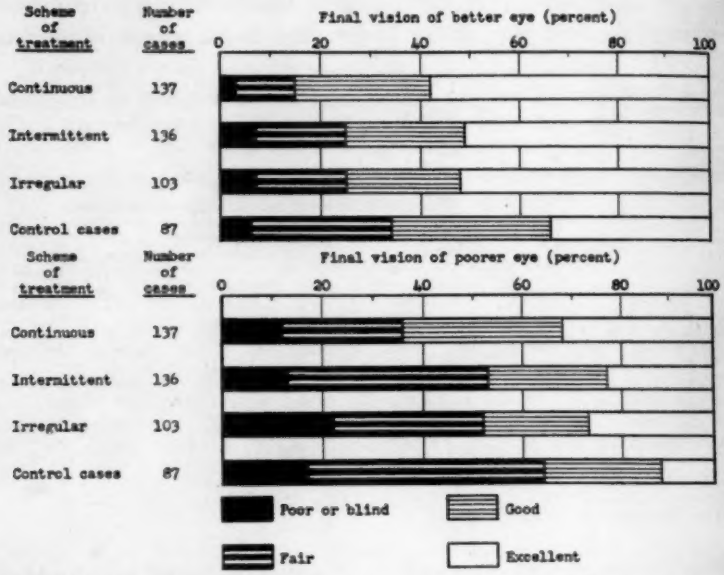

Chart 10.—Comparison of the final visual acuity of patients with interstitial keratitis following different plans of treatment with the final visual acuity of the control group.

were as follows: Malaria, 106.1 F.; typhoid vaccine or antigen H, 104.2 F.; pyrifer (colon bacillus), 105.8 F., and sterile milk (intramuscularly), 101.7 F.; with artificial fever therapy it ranged from 105.7 F. for vapothermy to 106.7 F. for hyperthermy.

Tables 6 and 7 compare the visual acuity on final examination of 173 eyes of patients treated with the four principal types of fever employed. Although the number in each group is small, best results seemed to be obtained with malaria and hyperthermy, the two types producing the highest temperature.

RECOMMENDATION FOR TREATMENT OF INTERSTITIAL KERATITIS

Obviously, it is better to prevent interstitial keratitis than to treat it. The objectives should be to treat the pregnant woman with syphilis to prevent congenital syphilis [14] and to treat early congenital syphilis to prevent interstitial keratitis.[1] But it is also axiomatic that, once interstitial keratitis has set in, the sooner it is treated the greater is the chance for excellent vision.

TABLE 6.—*Effect of Different Types of Fever Therapy on the Final Vision of Patients with Active Interstitial Keratitis*

Final Visual Acuity	Typhoid or Antigen "H"			Malaria			Sterile Milk			Hyperthermy (Alone or in Combination)		
		Per Cent			Per Cent			Per Cent			Per Cent	
	Number	Actual	Cumulative	Number	Actual	Cumulative	Number	Actual	Cumulative	Number	Actual	Cumulative
6/ 6	18	15.5	15.5	9	37.5	37.5	6	31.6	31.6	4	28.6	28.6
6/ 9	21	18.1	33.6	4	16.7	54.2	2	10.5	42.1	4	28.6	57.2
6/12	10	8.6	42.2	2	8.3	62.5	1	5.3	47.4	..	....	57.2
6/15	20	17.2	59.4	3	12.5	75.0	1	5.3	52.7	2	14.3	71.5
6/21	16	13.8	73.2	..	....	75.0	2	10.5	63.2	1	7.1	78.6
6/30	8	6.9	80.1	2	8.3	83.3	4	21.1	84.3	2	14.3	92.9
6/60	12	10.3	90.4	1	4.2	87.5	1	5.3	89.6	1	7.1	100.0
−6/60	9	7.8	98.2	1	4.2	91.7	..	....	89.6	..	....	100.0
Blindness	2	1.7	100.0	2	8.3	100.0	2	10.5	100.0	..	....	100.0
Total	116	100.0		24	100.0		19	100.0		14	100.0	

TABLE 7.—*Visual Acuity of 20/20 and 20/60 or Better on Final Examination After Treatment with Various Fever-Producing Agents*

Therapy	Visual Acuity	
	20/20, per Cent	20/60 or Better, per Cent
Malaria	38	75
Hyperthermy	29	72
Sterile milk	32	53
Typhoid or antigen H	16	59

The following scheme of treatment is recommended on the basis of the present study and the experience of the others.

FEVER THERAPY

Malaria or hyperthermy should be employed as soon after onset as possible. If these types are not available, another fever-producing agent should be substituted. Because arsenicals and bismuth are antimalarial,

14. Cole, H. N.; Moore, J. E.; O'Leary, P. A.; Stokes, J. H.; Wile, U. J.; Clark, T.; Parran, T.; Vonderlehr, R. A., and Usilton, L. J.: Cooperative Studies in the Treatment of Syphilis: Syphilis in Pregnancy, Ven. Dis. Inform. **15**:83-107, 1934.

they should be withheld during the course of induced malaria, but they should be given in the intervals between fever bouts produced by other agents.

Antisyphilitic Treatment

Neoarsphenamine or another trivalent arsenical (in full dose[15] in proportion to body weight) and bismuth subsalicylate should be given in alternating courses. Soluble bismuth, however, should be employed at the onset of treatment, simultaneous with arsenical therapy. The treatment should be continued according to the following schedule until approximately thirty injections of the arsenical and sixty of the bismuth compound have been administered:

Weeks 1 to 9: Neoarsphenamine, ten weekly doses; bismuth (soluble), eight doses, twice weekly, during first month
10 to 19: Bismuth, 10 weekly doses
20 to 29: Neoarsphenamine, ten weekly doses
30 to 39: Bismuth, ten weekly doses
40 to 44: Neoarsphenamine, five weekly doses
45 to 54: Bismuth, ten weekly doses
55 to 59: Neoarsphenamine, five weekly doses
60 to 69: Bismuth, ten weekly doses
70 to 73: Rest period
74 to 83: Bismuth, ten weekly doses

It is imperative that treatment be continuous at least throughout the active stage of the disease.

The administration of iodides is not recommended.

Refraction after disappearance of inflammatory symptoms is always desirable, since improvement in visual acuity may result.

SUMMARY AND CONCLUSIONS

A report is made of an analysis of 532 patients with interstitial keratitis who were treated or observed for at least one year.

Seventy-three per cent of the patients were white and 27 per cent Negro. Sixty per cent were females. The median age at onset was 12 years for females and 13 years for males.

Thirty per cent of patients with inactive interstitial keratitis previously treated had negative serologic reaction of the blood. Two and five-tenths per cent of patients with active interstitial keratitis who were untreated had negative reaction.

In 532 patients other syphilitic manifestations were incident in varying degree, as follows: Hutchinson teeth, 40 per cent; involvement of bones and joints, 35 per cent; labyrinthine disease, 10 per cent; chorio-

15. Although initial use of large doses of an arsenical is generally to be avoided in the treatment of other acute ocular lesions of syphilis because of the danger of Herxheimer's reaction in the involved eye, pragmatically this does not apply to interstitial keratitis. It is apparent that this procedure in treating interstitial keratitis very rarely aggravates the disease in the eye or in other organs.

retinitis, 8 per cent; neurosyphilis (symptomatic and asymptomatic), 8 per cent, and dementia paralytica (including the tabetic form), 0.4 per cent.

In 42 per cent of patients both eyes were involved either simultaneously or within one month of each other. The percentage with involvement of the second eye increased slowly to the tenth year. At this time the second eye had become involved in 79 per cent.

The effect of different schemes of treatment on final visual acuity, with or without refraction, was graphically represented. Different schemes of treatment comprised routine therapy (more than twenty injections of an arsenical or less than twenty injections in conjunction with a heavy metal), routine therapy with iodides, routine therapy with fever (malaria, mechanical fever therapy or vaccines intravenously) and routine therapy with iodides and fever. Treatment was also classified into continuous, intermittent and irregular.

It appeared that treatment administered in the inactive stage of interstitial keratitis was of limited value in improving visual acuity.

The importance of employing at least twenty injections of an arsenical in the active stage of the disease was emphasized. Arsphenamine and neoarsphenamine obtained approximately the same results.

The administration of iodides unfavorably influenced final visual acuity in patients both with active and with inactive interstitial keratitis.

The superiority of one plan of treatment over another involved an increase in the proportion of patients with excellent vision following treatment and not a decrease in the proportion whose sight remained poor.

Routine treatment supplemented with fever therapy was superior to other forms of treatment in preventing relapse. Of 55 patients thus treated only 1 had a relapse. Relapses after other types of treatment ranged from 13 to 18 per cent. Relapse was more frequent in patients treated with less than twenty injections of an arsenical than in patients treated with more than twenty injections.

Continuous treatment was superior to intermittent or irregular treatment only in regard to the final visual acuity of the poorer eye and in causing less poor visual acuity or blindness.

Best results were obtained in patients with active interstitial keratitis treated with an arsenical combined with the use of a heavy metal and fever therapy. This treatment resulted in the following final visual acuity (total eyes): excellent (20/30 to 20/20), 51 per cent; good (20/50 to 20/40), 17 per cent; fair (20/200 to 20/70), 22 per cent, and poor (less than 20/200) and blind, 10 per cent. This compared with the visual acuity (total eyes) of untreated patients (control group) as follows: excellent, 24 per cent; good, 27 per cent; fair, 37 per cent, and poor and blind, 12 per cent.

TREATMENT OF STAPHYLOCOCCIC BLEPHARO-CONJUNCTIVITIS WITH STAPHYLOCOCCUS TOXOID

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A previous report[1] summarized the results of treatment with staphylococcus toxoid in 57 cases of conjunctivitis in which toxin-producing staphylococci had been isolated. In 46 of these cases no other etiologic factors were found, but in the remaining 11 there were such associated factors as acne rosacea, cicatricial trachoma and allergy. In each case the conjunctivitis was long standing and had resisted local treatment for not less than two months. During the course of treatment with toxoid the local treatment which had previously failed was continued. Twenty-one of the 57 patients showed healing; 19 showed clinical improvement, and 17 showed no improvement. In only 24 of the 57 cases did the cultures become negative for toxin-producing staphylococci. Eight of the 21 patients in whom healing had occurred suffered a recurrence of symptoms; these symptoms disappeared after a second course of toxoid therapy. Recurrence appeared to be related to persistence of the organism on the lid margins, since it did not occur in any patient who had become totally free of toxigenic staphylococci.

The percentage of positive results in this initial series seemed to warrant further clinical trial of toxoid. Since this observation was made (August 1938), toxoid has been used in the treatment of more than 300 patients with staphylococcic infections of the external eye at the Vanderbilt Clinic and the Institute of Ophthalmology, and it is now possible to make a reasonable evaluation of its therapeutic worth. I now feel that it can be stated that immunization with staphylococcus toxoid is a valuable supplement to local therapy and that its value is greatest in cases in which conjunctival and corneal lesions predominate and least in cases in which blepharitis predominates.

As is well known, staphylococcic blepharitis and blepharoconjunctivitis are often extremely resistant to treatment, probably because of

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1. Thygeson, P.: Treatment of Staphylococcic Conjunctivitis with Staphylococcus Toxoid, Arch. Ophth. **20**:271 (Aug.) 1938.

the failure of local therapy to affect the organisms which lie in the glands and hair follicles of the lid margins. The many types of therapy advocated for these conditions indicate the general inefficacy of any one method. The present study is the first of a series dealing with the local and general treatment of staphylococcic blepharoconjunctivitis and is concerned with the value of staphylococcus toxoid as a supplement to local treatment.

Available for study were 83 patients with staphylococcic blepharoconjunctivitis of long duration which had failed to improve with the usual types of local therapy. The infections observed in these patients resisted a two month trial period of local treatment consisting of the instillation four times daily of a 1 : 5,000 solution of mercury oxycyanide and the application to the lid margins nightly (after removal of crusts) of a 2.5 per cent ammoniated mercury ointment. At the time the toxoid therapy was started all the patients showed gross blepharitis and large numbers of colonies of hemolytic Staphylococcus aureus in cultures of material from the lid margins and from the conjunctivas. The local treatment which had proved ineffective alone was continued during the period of toxoid therapy.

The course of treatment consisted of from twelve to fourteen weekly or biweekly injections of toxoid, the dose being increased from an initial 0.02 cc. to 1 cc. Doses up to 0.3 cc. were given intracutaneously and the remainder subcutaneously. If on completion of the course there was no improvement or if the cultures continued to show toxigenic staphylococci, the toxoid was continued in weekly doses of 0.5 cc. for at least one month.

The toxoid used was a digest-modified preparation (supplied for this study by the Lederle Laboratories), in which the staphylococcus toxin is modified by mild peptic digestion rather than by formaldehyde. In accordance with the observations of Parfentjev and co-workers,[2] who found this digest-modified toxoid possessed of marked antigenic properties but less likely to produce reactions in the patient than is the formaldehyde-treated type, there were strikingly fewer local reactions in this series than in the initial series, in which formaldehyde-treated toxoid had been employed. Although there were still a considerable number of patients who complained of local redness and swelling, no general febrile reactions occurred. A few patients complained of vague pains in the joints. A good example of the difference in this respect between the two types of preparation was seen in 1 case of severe staphylococcic blepharoconjunctivitis. Through an error, the formal-

2. Parfentjev, I. A.; Clapp, F. L., and Waldschmidt, A.: Staphylococcal Toxoid Prepared by Peptic Digestion, J. Immunol. **40**:189, 1941.

dehyde-treated toxoid was substituted at one time in the course of treatment for the digest-modified toxoid, a dose of 0.6 cc. being given subcutaneously; the patient's temperature rose to 103 F., and there was a severe spreading local reaction which the attending surgeon at first thought to be erysipelas and which required hospitalization for one week.

RESULTS OF TOXOID THERAPY

Of the 83 patients, 22 became clinically well, and all but 3 of these also became free from significant bacteria on both the conjunctivas and the lid margins. There were 53 patients who showed definite improvement of moderate or marked degree. Of these, only 8 became free from toxigenic staphylococci, and it is noteworthy that these 8 all showed

Antihemolysin Titers After Toxoid Immunization

Case and Patient	Titer Before Treatment, Units	Titer After Treatment, Units	Clinical Result
1. R. S.	Less than 0.37	4.5	Improved
2. A. H.	Less than 0.37	15	Unimproved
3. B. C.	Less than 0.37	1	Unimproved
4. J. P.	Less than 0.37	5	Improved
5. B. C.	Less than 0.37	10	Improved
6. M. G.	Less than 0.37	4	Improved
7. C. R.	Less than 0.37	0.4	Unimproved
8. C. S.	Less than 0.37	15	Improved
9. S. K.	Less than 0.37	Less than 0.37	Improved
10. J. S.	Less than 0.37	2	Improved
11. E. M.	Less than 0.37	Less than 0.37	Improved
12. B. R.	Less than 0.37	1	Improved
13. M. G.	Less than 0.37	7.5	Improved
14. M. E.	Less than 0.37	0.5	Improved
15. H. M.	Less than 0.37	Less than 0.37	Improved

striking improvement clinically, the conjunctivas and the corneas returning to normal in 6, with only mild hyperemia of the lid margins persisting. The other 2 had mild acne rosacea, which probably accounted for the persistence of the blepharoconjunctivitis despite the absence of significant bacteria. In 8 patients no improvement occurred, and in all of these pathogenic staphyococci persisted on the conjunctivas and on the lid margins.

Immunologic Response.—In an effort to acquire some data relative to the immunologic response to toxoid therapy the antihemolysin titer in 15 cases was determined before and after therapy. As can be seen in the table, there was no uniformity in the titers obtained after identical courses of toxoid; the highest titer was 15 units and was obtained in 2 cases. It may be noted that no rise in antihemolysin titer occurred in 3 cases, although all the patients showed some improvement after treatment. In 1 case (that of A. H.), in which there was a maximal

rise of antihemolysin, the conjunctivitis improved but the blepharitis was unaffected. In this small series there would appear to be no correlation between the antihemolysin titer and the clinical results.

Hypersensitivity.—There was considerable variation in the local reaction obtained in different patients to the initial intracutaneous injection of 0.02 cc. of toxoid. These cutaneous reactions, which were of the delayed type, varied in area from 1.0 cm. to as much as 10 cm. in diameter. In 7 cases it was necessary to modify the schedule of dosage because of the severity of the cutaneous reaction, and in 1 case (not included in this report) the use of toxoid was discontinued at the patient's request because of the local reaction. These reactions tended to diminish during the course of the injections and constituted no problem by the time the larger doses were being administered.

While no attempt was made to correlate the magnitude of the reaction to the initial dose with the clinical response to toxoid therapy, it became evident that better results could be expected in patients with marked cutaneous sensitivity. The question of bacterial allergy and of the desensitizing action of staphylococcus toxoid will be considered in a subsequent report.

COMMENT

This study confirms essentially the data obtained in the previously reported series of cases of toxoid-treated conjunctivitis. The somewhat less favorable results are probably to be accounted for by the fact that there was gross inflammation of the lid margins in all the cases of the second series but in only 24 of the 57 cases of the first series. The role of infection of the lid margins in preventing spontaneous healing of staphylococci conjunctivitis has been stressed previously.[3]

It seems reasonable to conclude that the toxoid was responsible, in the major part at least, for the favorable results, since the local treatment had failed when used alone during an extensive trial period. The effect of toxoid therapy is well illustrated by the cases of 2 patients who became free from symptoms after a course of toxoid in spite of the fact that cultures of material from the lid margins continued to yield bacteria. After one recurrence each, these patients have been kept free from symptoms for over two years by monthly injections of toxoid.

The second report in this series will deal with the local use of certain new chemotherapeutic agents, including sulfathiazole (2-[para-aminobenzenesulfonamido]-thiazole), in the treatment of staphylococcic blepharitis. It is sufficient to mention here that in certain cases the use of sulfathiazole ointment has effected clinical and bacteriologic cure of this condition after it has resisted all previous therapy.

3. Thygeson, P.: Bacterial Factors in Chronic Catarrhal Conjunctivitis, Arch. Ophth. **18**:373 (Sept.) 1937.

SUMMARY AND CONCLUSIONS

A series of 83 patients with staphylococcic blepharoconjunctivitis which had previously resisted local antiseptic therapy was treated by immunization with staphylococcus toxoid. The local treatment which had previously failed was continued in each case. Healing was obtained in 22 cases; moderate or marked improvement, in 53 cases, and little or no improvement, in 8 cases. The conjunctivitis in cases which became free from pathogenic staphylococci showed no tendency to recur, but in cases in which symptomatic but not bacteriologic cure was obtained it generally recurred in from three to six months. The use of staphylococcus toxoid would appear to be indicated as a supplement to local treatment in cases of resistant staphylococcic blepharoconjunctivitis.

OPHTHALMOSCOPICALLY VISIBLE RETINAL LESIONS IN CHRONIC GLOMERULONEPHRITIS

OCCURRENCE AND CHARACTERISTICS

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The relation between chronic nephritis and abnormal elevation of blood pressure has been a subject of discussion ever since the time of Bright. Even since the time of Allbutt,[1] who was the first person to distinguish clearly essential hypertension from chronic nephritis, no definite conclusion has been reached as to the part played by renal lesions in the development of retinitis in cases in which the blood pressure was increased.[2] The term "albuminuric retinitis," introduced by Liebreich,[3] in 1859, to describe the retinal changes that occur in cases of chronic nephritis, is still being used. As is often the case, the use of a descriptive term is continued in spite of the fact that it has proved to be a misnomer.

Bright,[4] in 1836, mentioned the fact that visual disturbances might occur in the course of chronic nephritis. The retinal changes that occur in cases of this disease were observed anatomically by Tuerck,[5] in 1850, and ophthalmoscopically by Heymann,[6] in 1856. Although it was admitted that changes in the retinal arteries do occur in cases of essential hypertension, until rather recently it remained the general opinion that the occurrence of the "albuminuric" type of retinitis always indicates the presence of chronic nephritis. This opinion was expressed by Moore,[7]

Work done under the direction and with the assistance of Dr. N. M. Keith, of the Division of Medicine, Dr. H. P. Wagener, of the Section on Ophthalmology, and Dr. J. W. Kernohan, of the Department of Pathologic Anatomy, the Mayo Clinic.

1. Allbutt, C.: Diseases of the Arteries Including Angina Pectoris, London, Macmillan & Company, Ltd., 1915, vol. 1.

2. Fishberg, A. M.: Hypertension and Nephritis, ed. 3, Philadelphia, Lea & Febiger, 1934.

3. Liebreich, cited by Fishberg.[2]

4. Bright, R.: Cases and Observations, Illustrative of Renal Disease Accompanied with the Secretion of Albuminous Urine, Guy's Hosp. Rep. **1**:338-379, 1836.

5. Tuerck, cited by Fishberg.[2]

6. Heymann, cited by Fishberg.[2]

7. Moore, R. F.: The Retinitis of Arterio-Sclerosis, and Its Relation to Renal Retinitis and to Cerebral Vascular Disease, Quart. J. Med. **10**:29-75 (Oct.-Jan.) 1916-1917.

in 1916, when he distinguished the retinitis of arteriosclerosis from the retinitis of nephritis.

Volhard,[8] in 1921, Wagener and Keith,[9] in 1924, and Keith, Wagener and Kernohan,[10] in 1928, in papers dealing with malignant hypertension, brought out the fact that the "albuminuric" type of retinitis can occur in cases in which there is no demonstrable inflammatory type of renal lesion or evidence of renal "insufficiency." In other words, this type of retinitis can occur in cases in which there is no clinically demonstrable renal change and in which necropsy reveals only essentially vascular lesions in the kidney.

Typical "albuminuric" retinitis is characterized ophthalmoscopically in its fully developed stage by visible sclerotic changes in the arterioles of the retina, edema of the optic disk, generalized grayish white edema of the retina, which is visible especially around the optic disk, hemorrhages, cotton wool patches and a radiating star figure in the macular region. Clinical experience has suggested that this type of retinitis, as a matter of fact, is seen more commonly in cases of primary diffuse arteriolar disease than in cases of primary glomerulonephritis. For this reason, 56 cases in which necropsy revealed definite evidence of chronic glomerulonephritis were studied with special reference to the occurrence and the types of retinal lesions.

MATERIAL

The material used in this study was selected from all cases of chronic glomerulonephritis in which necropsy was performed at the Mayo Clinic in the years 1920 to 1938 inclusive. Only cases in which at least one ophthalmoscopic examination had been performed by a consultant in the Section on Ophthalmology shortly before the death of the patient were selected. Fifty-six cases fulfilled these criteria. In several cases examination had been made at the clinic on more than one occasion. In all 56 a diagnosis of chronic glomerulonephritis had been made clinically according to the classification of Volhard and Fahr.[11] Cases in which the clinical diagnosis was chronic glomerulonephritis but in which necropsy revealed that the renal lesion was primarily vascular were

8. Volhard, F.: Ueber die Retinitis albuminurica, Verhandl. d. deutsch. Kong. f. inn. Med. **33**:422-426, 1921.

9. Wagener, H. P., and Keith, N. M.: Cases of Marked Hypertension, Adequate Renal Function and Neuroretinitis, Arch. Int. Med. **34**:374-387 (Sept.) 1924.

10. Keith, N. M.; Wagener, H. P., and Kernohan, J. W.: The Syndrome of Malignant Hypertension, Arch. Int. Med. **41**:141-188 (Feb.) 1928.

11. Volhard, F., and Fahr, T.: Die Brightsche Nierenkrankheit; Klinik, Pathologie und Atlas, Berlin, Julius Springer, 1914.

excluded from this series. The principal cause of death in the 56 cases was chronic glomerulonephritis. The secondary causes of death were as follows: uremia in 87 per cent, myocardial insufficiency in 9 per cent and bronchopneumonia or some other terminal infection in 4 per cent.

PATHOLOGIC CHANGES IN THE KIDNEYS

The kidneys were examined both macroscopically and microscopically. They were not all small and contracted, as kidneys usually are in this disease. In fact, about half of them were large and swollen. The sections were stained with hematoxylin and eosin and with the Mallory-Heidenhain stain. The latter stain was of particular value in the detailed examination of the glomeruli and has been recommended by both Bell [12] and McGregor,[13] who have made studies of both normal and abnormal kidneys.

The typical changes seen in the kidneys were similar to those described by Fahr,[14] Bell [12a] and McGregor.[13b] The glomeruli showed division into lobules more clearly than is seen in normal kidneys. The capillary loops were involved to a varying degree; in the more seriously diseased glomeruli there were very few patent loops remaining, and those that remained patent were at the periphery of the lobules. The central capillaries were obstructed by an increase in the number of endothelial cells and by the presence of intracapillary fibers. Some glomeruli showed partial and others complete hyalinization, depending on whether a few or all of the capillaries were involved. Crescent formation, both old and recent, as determined by the cellosity, was noted in many cases. In cases in which recent or very cellular crescents were present there had been clinical evidence of an acute exacerbation of chronic glomerulonephritis. In examination of the sections, it was noted that the process was diffuse, involving almost all the glomeruli to some degree.

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12. (*a*) Bell, E. T.: A Textbook of Pathology, ed. 3, Philadelphia, Lea & Febiger, 1938, pp. 416-482; The Early Stages of Glomerulonephritis, Am. J. Path. **12**:801-824 (Nov.) 1936; A Clinical and Pathological Study of Subacute and Chronic Glomerulonephritis, Including Lipoid Nephrosis, ibid. **14**:691-736 (Nov.) 1938. (*b*) Bell, E. T., and Clawson, B. J.: Primary (Essential) Hypertension: A Study of Four Hundred and Twenty Cases, Arch. Path. **5**:939-1002 (June) 1928. (*c*) Bell, E. T., and Hartzell, T. B.: The Etiology and Development of Glomerulonephritis, Arch. Int. Med. **29**:768-820 (June) 1922.

13. McGregor, L.: (*a*) The Finer Histology of the Normal Glomerulus, Am. J. Path. **5**:545-558 (Nov.) 1929; (*b*) The Cytological Changes Occurring in the Glomerulus of Clinical Glomerulonephritis, ibid. **5**:559-585 (Nov.) 1929; (*c*) Histological Changes in the Renal Glomerulus in Essential (Primary) Hypertension: A Study of Fifty-One Cases, ibid. **6**:347-366 (May) 1930.

14. Fahr, T.: Ueber herdförmige Glomerulonephritis, Virchows Arch. f. path. Anat. **225**:24-44, 1918.

The kidney in cases of essential hypertension, on the other hand, has a thickened and irregular glomerular basement membrane which obstructs the capillary tufts. This is the predominating glomerular change. There are hyaline and a few inflammatory glomeruli and a definite number of normal glomeruli in this type of kidney. The vascular changes in the arterioles are much more marked in such kidneys than in the kidney in cases of chronic glomerulonephritis, except in those few cases in which diffuse arteriolosclerosis has been superimposed on chronic glomerulonephritis.

Distinct glomerulitis was seen in every case of chronic glomerulonephritis. The greater the number of hyaline glomeruli, the greater was the amount of interstitial connective tissue and the greater was the atrophy of the tubules. The remaining functionally active glomeruli and tubules were hypertrophic. In some cases collections of lymphocytes were seen in the interstitial tissues, usually close to the hyaline glomeruli.

In the majority of cases the arterioles either were normal or showed a minimal grade of sclerosis. However, in some cases a moderate degree of arteriolosclerosis was present, with thickening of the wall and narrowing of the lumen of the vessel. In the arterioles in the atrophic and scarred regions, a type of change was noted which is associated with disuse, because of a functionally diminished blood supply to the affected part. In this type of arteriolar lesion there is usually more intimal involvement than in the lesion caused by the ordinary type of arteriolosclerosis. In a few cases arteriolosclerosis was pronounced. In these the arterioles in other organs were involved similarly. These cases will be considered later in greater detail. There was, of course, arteriosclerosis of the larger renal vessels in cases in which the patient was middle aged or elderly.

The combined weight of the kidneys was recorded in 52 cases (table 1). This weight was greater than normal in 23 cases and less than normal in 29 cases. In the majority of cases the kidneys were granular and the cortices were thin and indistinct.

WEIGHT OF THE HEART

The weight of the heart also was recorded in 52 cases (table 1). It was greater than normal in 49 cases, normal in 1 case and less than normal in 2 cases.

INCIDENCE AND GENERAL CONSIDERATION OF RETINAL LESIONS

To clarify the system of classification employed in this study of 56 cases of chronic glomerulonephritis, a numerical résumé has been prepared (table 2).

In 10 of the 56 cases the ocular fundi remained normal until death (table 2). In 2 other cases the fundi were normal shortly before death but a few hemorrhages had been noted previously.

TABLE 1.—*Weight of Heart and Kidneys in Patients with Chronic Glomerulonephritis*

Case	Weight of Heart, Gm.		Weight of Kidneys, Gm.			
			Individual		Combined	
	Actual	Estimated Normal *	Right	Left	Actual	Estimated Normal *
1	157	106	197	214	411	128.5
2	195	125	118	120	238	155
3	475	311.1	Horseshoe		450	302.1
4	345	313.4	174	Study †	...	293.7
5	238	260	233	253	486	291
6	368	301.7	170	180	350	302.8
7	Not weighed		120	102	222	302.8
8	575	301.7	203	91	294	302.8
9	427	301.7	200	208	408	302.8
10	345	301.7	193	229	422	302.8
11	180	123	80	80	160	133
12	360	301.7	100	100	200	302.8
13	237	173.8	166	186	352	190
14	300	253.5	180	165	345	249
15	275	260.9	40	50	90	291.6
16	610	301.7	163	143	306	302.8
17	456	260.9	103	130	233	291.6
18	245	264.3	224	233	457	253.4
19	360	250.9	165	193	358	274.9
20	320	234.4	168	168	336	277
21	Not weighed		...	...	400	274.3
22	Not weighed		...	...	...	.....
23	450	260.9	150	108	258	291.6
24	400	301.7	75	80	155	302.8
25	567	301.7	85	87	172	302.8
26	360	301.7	155	157	312	302.8
27	490	301.7	105	131	236	302.8
28	315	260.9	212	202	413	291.6
29	546	301.7	96	93	189	302.8
30	434	301.7	95	65	160	302.8
31	603	301.7	121	103	224	302.8
32	545	301.7	197	207	404	302.8
33	456	301.7	100	83	183	302.8
34	329	260.9	60	64	124	291.6
35	490	301.7	127	Nephrectomy		302.8
36	394	301.7	24	84	108	302.8
37	435	260.9	89	96	185	291.6
38	Not weighed		88	92	180	302.8
39	573	301.7	150	158	308	302.8
40	425	301.7	87	84	171	302.8
41	350	260.9	65	90	155	291.6
42	585	301.7	130	140	270	302.8
43	375	260.9	162	152	314	291.6
44	575	301.7	59	70	129	302.8
45	438	301.7	100	109	209	302.8
46	610	260.9	127	87	214	291.6
47	405	234.4	51	65	116	277
48	340	313.4	333	333	666	293.7
49	500	301.7	175	80	255	302.8
50	445	311.1	100	104	204	302.1
51	300	301.7	180	200	380	302.8
52	598	301.7	144	159	303	302.8
53	575	301.7	226 (with capsule)	63	...	302.8
54	475	301.7	130	60	190	302.8
55	388	301.7	99	95	194	302.8
56	425	301.7	47	54	101	302.8

* According to the method of Vierordt (Vierordt, H.: Anatomische physiologische und physikalische Daten und Tabellen zum Gebrauche für Mediziner, Jena, Gustav Fischer, 1906).
† The kidney was removed for special study but was not weighed.

In 7 cases, including the 2 just mentioned, ophthalmoscopic examination disclosed a few hemorrhages in the retina. In 1 case, in which

hemorrhages were observed shortly before death, a few cotton wool patches also were observed. The retinal vessels were normal in all of the 7 cases. The hemorrhages in these (table 2) were of the type seen frequently in cases of severe anemia and were considered to be attributable to the anemia associated with chronic glomerulonephritis and not to the renal lesion per se (fig. 1).

In each of the remaining 39 cases the retinal picture resembled some phase of so-called albuminuric retinitis (table 2). Edema of the retina, cotton wool patches, hemorrhages and abnormalities in the retinal vessels were present in all of these cases. Edema of the optic disk often was observed. Partial and complete macular stars were present in cases in which the retinitis had been present for at least four to six weeks. In nearly all the cases the onset of the retinitis, as determined by subjective

TABLE 2.—*Numerical Résumé of Fifty-Six Cases of Chronic Glomerulonephritis Classified According to Nature or Absence of Retinal Lesions*

Condition of Ocular Fundi		Number of Cases
Normal*		10
Retinitis of anemia		7
Acute angiospastic retinitis ("albuminuric retinitis")		39
Thirty-one cases of acute angiospastic retinitis without chronic sclerosis of retinal arterioles	31	
Eight cases of acute angiospastic retinitis with chronic sclerosis of retinal arterioles	8	
One case of retinitis simulating that of diffuse arteriolar disease with hypertension (group 3)	1	
Seven cases of retinitis simulating that of diffuse arteriolar disease with hypertension (group 4)	7	
Total for series		56

* In 2 additional cases the ocular fundi were normal at death of patients, but hemorrhage had been observed at some period prior to death. Therefore, these 2 cases have been classified as cases of retinitis of anemia.

disturbances of vision, had been sufficiently abrupt to justify considering it as acute. Since the retinitis simulated closely that seen in hypertensive toxemia of pregnancy and in the vasospastic forms of primary hypertensive disease,[15] it seems justifiable, in the light of present knowledge, to consider that it was angiospastic in type or origin. The term acute angiospastic retinitis, therefore, has been used in this paper to replace the term albuminuric retinitis.

In each of the 39 cases ophthalmoscopic examination disclosed generalized narrowing of the retinal arterioles. At times this was associated with localized angiospastic narrowing which resembled, but on the whole was much less noticeable than, that seen in cases of hyper-

15. Habein, H. C., and Wagener, H. P.: Acute Vasospastic Hypertension, Minnesota Med. **20**:180-182 (March) 1937. Keith, N. M., and Wagener, H. P.: Acute Vasospastic Hypertension: A Case with Signs of Cerebral Irritation and Severe Retinitis with Remission, Am. J. M. Sc. **190**:454-459 (Oct.) 1935.

tensive toxemia of pregnancy. A demonstrable grade of chronic sclerosis in the walls of the arterioles (characterized by exaggeration of the arterial reflex stripe, change in color of the arterioles and arteriovenous compression) was observed in only 8 cases.

This type of chronic arteriolar lesion is seen most frequently in cases of diffuse arteriolar disease of the essential hypertension type and is considered to be, in the main, indicative of the presence of a diffuse lesion of the arterioles throughout the body.[16] In this report the retinitis associated with chronic sclerosis of the retinal arteries has been designated in two ways: (1) acute angiospastic retinitis of diffuse arteriolar disease with hypertension of group 3 (absence of edema of the optic disk) and (2) acute angiospastic retinitis of diffuse arteriolar disease with hypertension of group 4 (edema of the optic disk). In 1 case in this series the retinitis was of the first type and in 7 cases it was of the second type (table 2). The second type is indistinguishable ophthalmoscopically from the retinitis of malignant hypertension except

Fig. 1.—The ocular fundus of a patient suffering from chronic glomerulonephritis. Two small hemorrhages of the anemic type may be seen; one is between the optic disk and macula, and the other is at the first branching of the inferior temporal arterioles. The grayish areas above and below the macula represent a heightened reflex of the retina to light and are not pathologic.

in cases in which the secondary anemia accompanying the chronic glomerulonephritis is of sufficient grade to be visible in the optic disk and retina. In the absence of a demonstrable extraneous factor for the anemia, the presence of anemia of the optic disk in association with retinitis of the malignant hypertensive type always suggests that the malignant hypertension or diffuse arteriolar disease has occurred as a complication of chronic glomerulonephritis. In most of the cases in this series edema seemed to be confined essentially to the retina. In 2 cases, however, the subretinal edema was sufficient to indicate an

16. Morlock, C. G.: Arterioles of the Pancreas, Liver, Gastro-Intestinal Tract and Spleen in Hypertension, Arch. Int. Med. **63**:100-118 (Jan.) 1939. Odel, H. M.: Structural Changes in the Arterioles of the Myocardium in Diffuse Arteriolar Disease with Hypertension Group 4, ibid. **66**:579-602 (Sept.) 1940.

underlying disturbance of the choroidal circulation, which also may be primarily angiospastic. Involvement of the choroidal arteries in the angiospastic process may indicate a more extensive generalized vasospastic lesion than does spasm of the retinal arterioles alone and therefore a more serious prognosis.

On this basis it is possible to divide the 46 cases in the series in which some type of retinitis was present into two main groups: (1) those (7 cases) in which an anemic type of retinitis was present and (2) those (39 cases) in which an acute angiospastic type of retinitis was present (table 2). In 2 of the 7 cases of retinitis of anemia, the retinitis cleared up before death.[17] Also, in 3 of the 39 cases of acute angiospastic retinitis, retinitis disappeared before death.

The 39 cases of acute angiospastic retinitis can be subdivided further into two groups: (1) 31 cases of acute angiospastic retinitis without preexisting chronic sclerosis of the retinal arterioles and (2) 8 cases of acute angiospastic retinitis superimposed on preexisting chronic sclerosis of the retinal arterioles (table 2). In the second group the retinal picture[18] simulated: (1) diffuse arteriolar disease with hypertension of group 3 (1 case) and (2) diffuse arteriolar disease with hypertension of group 4, so-called malignant hypertension (7 cases, table 2).

CLINICAL AND LABORATORY DATA

In tables 3 and 4 a few of the more important clinical and laboratory observations are given. In table 3 it is noted that there was an antecedent history of infection in 45 of the 56 cases; the heart was enlarged on percussion in 32 cases, and definite palpable peripheral sclerosis was present in 41. The duration of symptoms and of life after the onset of symptoms was variable; the mean values are given in table 3. Edema, either localized or generalized, was noted in 38 cases. Readings of blood pressure were elevated at some time in all but 4 cases, in which the patients were members of the group of 10 who had normal fundi (table 2). The mean readings of blood pressure were normal for the patients who had normal fundi but were elevated for all the others. A gradual increase in blood pressure was noted in the various groups, but in the cases of retinitis of diffuse arteriolar disease with hypertension of group 4 the mean values for blood pressure were the highest.

17. These 2 cases were classified with those of retinitis of anemia because hemorrhage had been observed at some time prior to death.

18. The classification of the retinal lesions is that used by Dr. N. M. Keith, of the Division of Medicine, and Dr. H. P. Wagener, of the Section on Ophthalmology (Keith, N. M.; Wagener, H. P., and Barker, N. W.: Some Different Types of Essential Hypertension: Their Course and Prognosis, Am. J. M. Sc. **197**:332-343 [March] 1939. Wagener, H. P., and Keith, N. M.: Diffuse Arteriolar Disease with Hypertension and the Associated Retinal Lesions, Medicine **18**:317-430 [Sept.] 1939).

There is seen to be definite anemia in each group, and there was, of course, some degree of anemia in every case. The mean values for blood urea were elevated in all groups, and only 2 patients had normal readings

TABLE 3.—*Clinical Data in Fifty-Six Cases of Chronic Glomerulonephritis*

Retinal Lesions	Cases	Sex		Mean Age at Death, Years	Mean Duration of Symptoms Before First Examination, Years	Mean Duration of Life After Onset of Symptoms, Years	Antecedent History of Infection	Enlargement of Heart Disclosed by Percussion	Palpable Sclerosis of Peripheral Arteries	Edema	Systolic and Diastolic Blood Pressure	
		M	F								Range	Mean Values
None.....	10	7	3	37	0.8	2.5	9	4	4	8	95/60 to 190/130	140/85
Retinitis of anemia	7	2	5	28	4.5	5.0	6	5	4	5	110/80 to 220/125	155/95
Acute angiospastic retinitis without chronic retinal arteriolosclerosis	31	21	10	32	4.0	4+	24	18*	25	21	135/90 to 270/160	180/115
Acute angiospastic retinitis with chronic retinal arteriolosclerosis (retinitis of diffuse arteriolar disease with hypertension)	8	8	0	45	3.5	4.5	6	5	8	4	140/100 to 270/170	195/115

* Necropsy disclosed enlargement of the heart in 24 of the 31 cases in which angioplastic retinitis without chronic retinal arteriolosclerosis was present.

TABLE 4.—*Laboratory Data in Fifty-Six Cases of Chronic Glomerulonephritis*

Types of Retinitis	Blood				Urine		
	Hemoglobin, per Cent *		Urea, Mg. per 100 Cc.†		Albumin, Grade	Casts in Each Field Viewed Under High Power Objective, Grade	Erythrocyturia, Grade
	Range	Mean	Range	Mean			
None.....	33-69	49	38-498	220	4	1	2
Retinitis of anemia	25-55	39	112-422	286	3	1	1
Acute angiospastic retinitis without chronic retinal arteriolosclerosis	20-74	46	36-597	298	2	Occasional cast	An occasional erythrocyte
With chronic retinal arteriolosclerosis (retinitis of diffuse arteriolar disease with hypertension)	35-70	56	102-657	332	2	Varied from an occasional cast to 1	Varied from an occasional erythrocyte to 2

* In the early cases the concentration of hemoglobin was estimated by the method of Dare. In the majority of cases it was determined with the Cenco-Sheard-Sanford electrophotelometer.

† The concentration of blood urea was chosen as an index of renal function as in the 56 cases this determination had been used more frequently than any other tests for renal function.

when they died. Albumin, casts and erythrocytes were present in the urine in various grades in the groups studied. Albumin and erythrocytes were present in every case.

PATIENTS WHO HAD NORMAL FUNDI

Since it is claimed by some authors, notably Cannady and O'Hare,[19] that all patients who have chronic glomerulonephritis will have retinal lesions before death, the time relation of the ophthalmoscopic examination to the date of death is important in the group of patients in which the fundi were said to be normal. In 11 of the 12 patients in whom the ocular fundi were normal at death (in 10 they were constantly normal; in 2 [17] hemorrhages had been observed previously, but the fundi were normal at death), the last ophthalmoscopic examination was recorded less than three weeks before death. The twelfth patient was examined within a few days of death, but unfortunately no written record was made of the examination. Four, 2 and 4 patients died within two weeks, one week and two days, respectively, of the last-recorded ophthalmoscopic examination.

In the whole group of patients with normal fundi a disturbance of vision was noted in only 1. Blurring of vision was complained of two years before the death of the patient. It was found to be the result of compound myopic astigmatism. The fundus was normal at the time of examination and in following examinations remained normal. All of the patients died in the presence of uremia with the exception of 1 whose blood urea was of normal concentration, 38 mg. per hundred cubic centimeters. This patient died of cardiac failure and terminal bronchopneumonia.

The 2 patients [17] in whom an anemic type of retinitis was observed at some period during the illness but in whom the fundi were normal shortly before death also may be considered in this group. A consideration of all 12 patients (10 in whom ocular fundi were normal constantly and 2 in whom previous hemorrhage had occurred but in whom the fundi were normal at death) showed that general edema was present in 9, an elevated blood pressure in 8 and an elevated terminal value for blood urea in 11. Of the 8 patients who had an elevated blood pressure, 6 had edema and 2 did not. The concentration of hemoglobin varied from 31 to 69 per cent,[20] with a mean of 43 per cent for the whole group.

A report of a case illustrative of a patient suffering from chronic glomerulonephritis but with normal fundi one week before death follows.

A man 24 years old (case 4 in table 1) entered the Mayo Clinic on Jan. 10, 1928, with a history of albuminuria for the previous year and swelling of the face, hands and legs, which followed a cold and sore throat, for the previous

19. Cannady, E. W., and O'Hare, J. P.: A Critical Survey of the Retinal Lesions in Chronic Glomerular Nephritis, J. A. M. A. **103**:6-10 (July 7) 1934.

20. In the early cases the concentration of hemoglobin was estimated by the method of Dare. In the majority of cases it was determined with the electrophotometer (Cenco-Sheard-Sanford).

two months. General examination disclosed swelling of the eyelids and ankles. The blood pressure readings ranged from 160 systolic and 60 diastolic to 160 systolic and 85 diastolic, expressed in millimeters of mercury. The concentration of hemoglobin was 48 per cent and that of blood urea 435 mg. per hundred cubic centimeters. Urinalysis showed a specific gravity of 1.015, albuminuria (grade 4), hyaline and granular casts (grade 1), erythruria (grade 1) and leukocyturia (grade 3). The ocular fundi on January 12 showed anemic pallor of the disks and retinal vessels of rather small caliber. A diagnosis of chronic glomerulonephritis with an acute exacerbation was made. The patient died in the presence of uremia on January 19, with a terminal value for blood urea of 496 mg. per

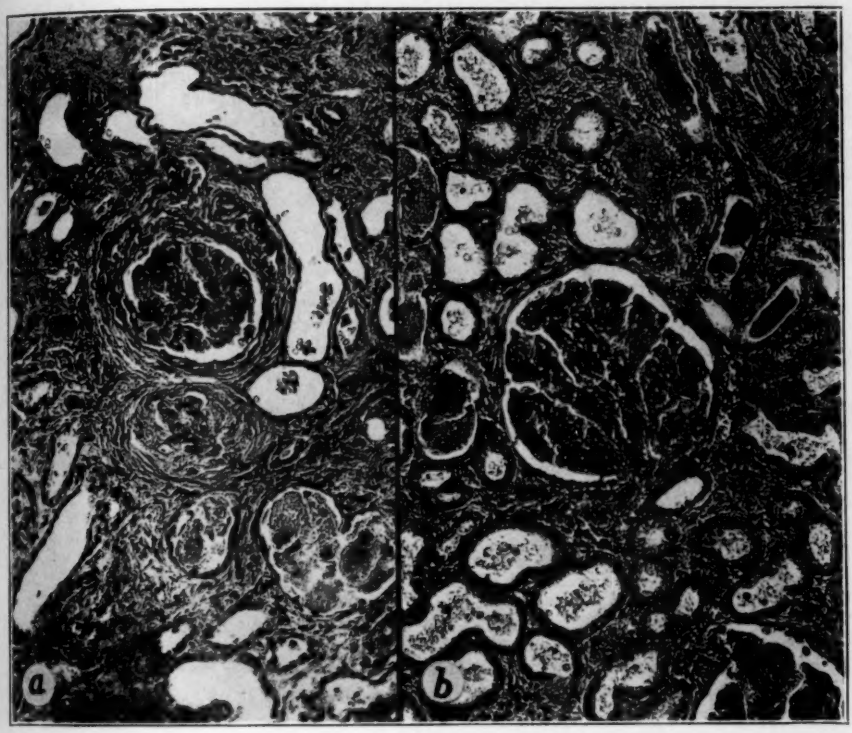

Fig. 2.—Sections of kidney from patients with normal ocular fundi (hematoxylin and eosin, × 150), showing (*a*) apparent lobulation of glomerulus with cellular crescent formation and almost completely hyalinized glomerulus, dilated tubules with hyaline casts and increase in connective tissue (case 4 on table 1) and (*b*) lobulation of glomerulus, dilated tubules with hyaline casts, increase in connective tissue and no arteriolar changes (case 5 on table 1).

hundred cubic centimeters. A photomicrograph of a section from a kidney of this patient is shown in figure 2 *A*.

This patient with chronic glomerulonephritis had normal fundi one week before death, in spite of the fact that the blood urea amounted to

435 mg. per hundred cubic centimeters and the hemoglobin to 48 per cent. The diastolic blood pressure was normal, and there was only a slight elevation in the value for systolic blood pressure.

Figure 2 *B* is a photomicrograph of a section of the kidney from a patient (case 5 in table 1) who likewise had normal ocular fundi.

PATIENTS WHO HAD RETINITIS OF ANEMIA

Seven patients had hemorrhages of the anemic type in the retina. In 2 of them the hemorrhages disappeared while the patients were under observation and the fundi were normal at the time of death. In 1 occasional blurring of vision was complained of for two weeks previous to the final admission of the patient. The retinitis present at the time of admission persisted until death, which occurred three weeks later. The clinical and laboratory data for patients in this group are recorded in tables 3 and 4.

A report of a case of retinitis of anemia follows.

A woman aged 26 (case 15 in table 1) first came to the Mayo Clinic on Dec. 18, 1915, because she had had headaches for the previous three and one-half years. She had undergone pregnancy one and one-half years previously and had had influenza about the same time. After that there had been albumin in the urine. The results of general examination were essentially normal. The blood pressure reading was 130 systolic and 80 diastolic, expressed in millimeters of mercury. The urine had a specific gravity of 1.015. Albuminuria (grade 2), hyaline casts (grade 1) and leukocyturia (grade 3) were present.

The patient returned on Aug. 8, 1918 and was found to be seven months pregnant (her second pregnancy). There was edema of the ankles; the blood pressure reading was 150 systolic and 90 diastolic, expressed in millimeters of mercury, and the urine had a specific gravity of 1.016. Albuminuria (grade 3), erythruria (grade 1) and leukocyturia (grade 4) were present.

The patient returned on Nov. 3, 1920, with a history of headaches, nausea, vomiting and convulsions which had occurred before the delivery of her fourth child four months previously. She had been told by her local physician that there was albumin in the urine and that her blood pressure was elevated. The blood pressure readings ranged from 140 systolic and 120 diastolic to 195 systolic and 135 diastolic, expressed in millimeters of mercury. The concentration of hemoglobin was 70 per cent, and albuminuria (grade 3), erythruria (grade 1) and leukocyturia (grade 3) were present. The ocular fundi were normal. A diagnosis of chronic glomerulonephritis was made.

The patient returned on Jan. 20, 1921 and again on May 11. The range of blood pressure readings was from 155 systolic and 100 diastolic to 175 systolic and 120 diastolic, expressed in millimeters of mercury; the concentration of hemoglobin was 67 per cent and that of blood urea 88 mg. per hundred cubic centimeters. Examination of the urine revealed a specific gravity of 1.010, albuminuria (grade 3), occasional casts, erythruria and leukocyturia (grade 1). The results of ophthalmoscopic examination on January 20, February 16 and May 11 all were normal.

The patient returned to the clinic on June 14, 1922, with a history of influenza three months previously and of fatigue and blurring of vision of two weeks'

duration. The general examination revealed pallor (grade 1) and a trace of edema of the legs. The blood pressure reading was 165 systolic and 90 diastolic, expressed in millimeters of mercury, and the concentration of hemoglobin was 55 per cent. The concentration of blood urea was 344 mg. per hundred cubic centimeters, and the urine had a specific gravity of 1.008. Albuminuria, erythruria and leukocyturia (each grade 1) were present. The ocular fundi showed slight edema of the disks and a few hemorrhages of the anemic type in each retina but no vascular changes. The patient died on July 4 of terminal pulmonary edema. The terminal value for blood urea was 422 mg. per hundred cubic centimeters.

In this case an anemic type of retinitis developed in the presence of a hemoglobin concentration of 55 per cent. In all the other 6 cases the concentration of hemoglobin was lower, ranging from 25 to 50 per

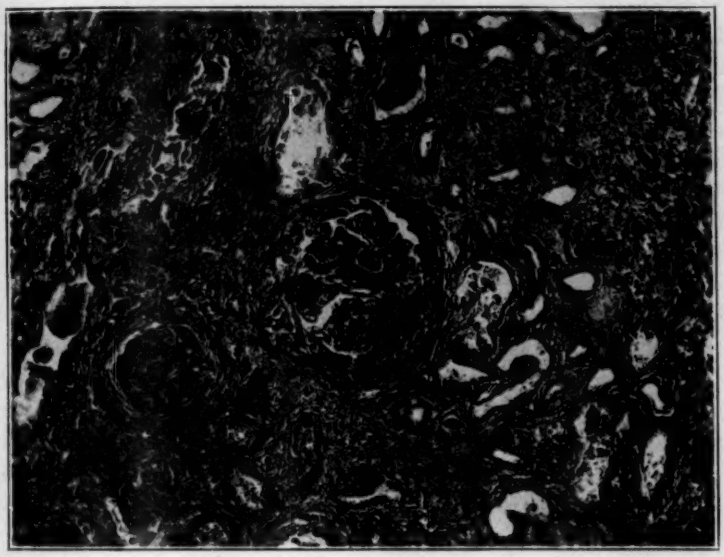

Fig. 3.—Section of kidney from a patient who had chronic glomerulonephritis and an anemic type of retinitis (case 12 on table 1), showing lobulations of glomerulus with crescent formation, hyaline glomerulus, atrophic tubules, increase in connective tissue and hyaline casts in some tubules (hematoxylin and eosin, × 150).

cent, and the mean value in the 7 cases was 39 per cent. The blood pressure was lower on this patient's last visit than it had been at previous visits, when the retinas were normal. The concentration of urea in the blood was markedly elevated. The duration of the life of this patient was only five weeks after the onset of disturbance of vision.

Figure 3 is a photomicrograph of a section of the kidney from a patient (case 12 in table 1) who had chronic glomerulonephritis and the anemic type of retinitis.

PATIENTS WHO HAD ACUTE ANGIOSPASTIC RETINITIS

Under this main heading 39 patients will be considered, who were divided into two lesser groups: (1) 31 patients who had acute angiospastic retinitis *without* chronic sclerosis of the retinal arterioles and (2) 8 patients who had acute angiospastic retinitis *with* chronic sclerosis of the retinal arterioles (table 2).

Acute Angiospastic Retinitis Without Chronic Sclerosis of the Retinal Arterioles.—Three types of patients were encountered in this particular category: (1) those in whom retinitis remained active until death, (2) those in whom retinitis cleared up without residual retinal or vascular changes and (3) those in whom retinitis cleared up but in whom there were residual postspastic lesions in the arterioles.

1. Active Acute Angiospastic Retinitis: In this group were 28 patients, of whom 20 were males and 8 were females. Clinical and laboratory data concerning these patients will be found in tables 3 and 4. The microscopic picture of the kidneys was typical of chronic glomerulonephritis, and there was a moderate degree of arteriolosclerosis in only 3 patients. The history of definite subjective disturbance of vision and the apparent age of the retinitis were used as a basis for the determination of the approximate duration of life after the onset of retinitis, which in this group varied from four days to fifteen months, with a mean of three and one-half months. Of 2 patients who also had involvement of the choroidal arteries in the angiospastic process, the duration of retinitis was four days for one and two months for the other.

Figure 4 *A* is a photograph of the fundus of a patient suffering from chronic glomerulonephritis in whom acute angiospastic retinitis without chronic sclerosis of the retinal arterioles was observed ophthalmoscopically.

A report of a case illustrative of active acute angiospastic retinitis without chronic sclerosis of the retinal arterioles follows.

A girl 15 years old (case 20 in table 1) entered the Mayo Clinic on June 1, 1922 for a tonsillectomy because of frequent attacks of tonsillitis. The results of general examination were essentially normal except for the observation of large tonsils. The blood pressure readings ranged from 120 systolic and 80 diastolic to 140 systolic and 95 diastolic, expressed in millimeters of mercury. The concentration of hemoglobin was 67 per cent and that of blood urea 21 mg. per hundred cubic centimeters. The urine showed a specific gravity of 1.020. Albuminuria (grade 2), erythruria (grade 1) and leukocyturia (grade 1) were present. The results of ophthalmoscopic examination were normal. Tonsillectomy was performed, and the patient was sent home to follow a diet with restricted intake of protein and salt. A diagnosis of acute glomerulonephritis was made.

The patient returned on Aug. 18, 1923, for a check-up. During the winter of 1922-1923 she had had a head cold followed by edema of the ankles for a short period. The general examination revealed slight edema of the ankles. The blood

pressure reading was 130 systolic and 80 diastolic, expressed in millimeters of mercury; the concentration of hemoglobin was 70 per cent, and the blood urea amounted to 23 mg. per hundred cubic centimeters. The urine had a specific gravity of 1.008. Albuminuria (grade 3), leukocyturia (grade 1) and occasional casts were present. The ocular fundi were normal. A diagnosis of chronic glomerulonephritis was made.

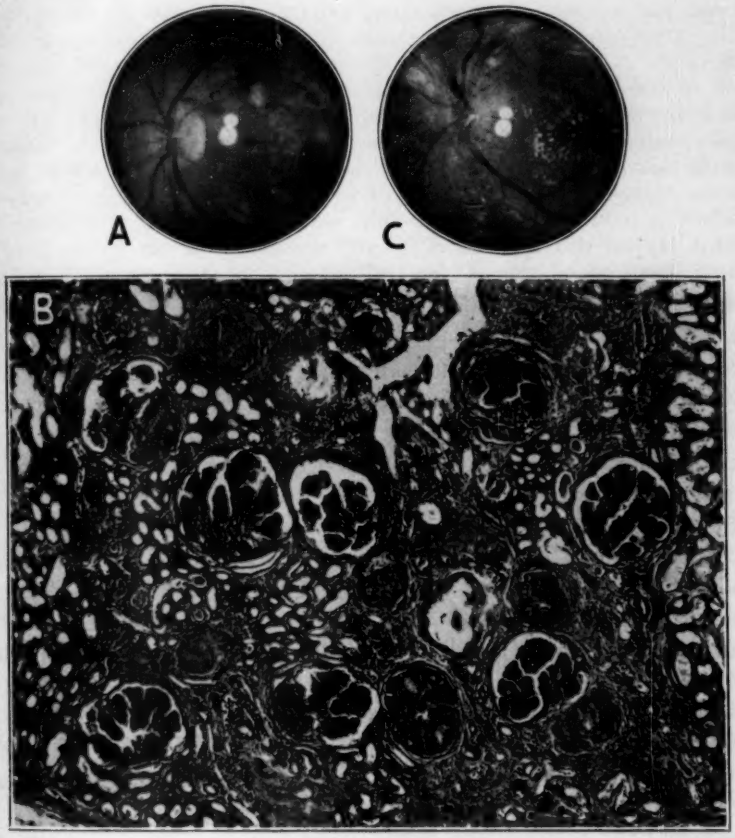

Fig. 4.—*A*, retina of a patient with chronic glomerulonephritis accompanied by the acute angiospastic type of retinitis without chronic sclerosis of the retinal arterioles. Mild edema of the optic disk and retina, a cotton wool patch in the temporal part of the retina and narrowing of the retinal arterioles without sclerosis can be seen. The diffuse grayish areas above the macula are heightened retinal reflexes. *B*, section of the kidney from a patient (case 47 in table 1) with chronic glomerulonephritis and the acute angiospastic type of retinitis, showing crescent formation, lobulation of glomeruli, hyaline glomeruli, atrophic tubules, with hyaline casts in some, and an increase in connective tissue (Mallory-Heidenhain stain, × 50). *C*, the ocular fundus of a patient with chronic glomerulonephritis and retinitis simulating that present in diffuse arteriolar disease with hypertension group 4 (malignant hypertension). Noticeable are edema of the optic disk, cotton wool patches, hemorrhages, the formation of a macular star and definite narrowing and sclerosis of the arterioles.

The patient returned again on Sept. 4, 1924, with a history of edema, dyspnea, headache and dimness of vision for four months, which had followed influenza and an attack of "appendicitis." Examination revealed general anasarca (grade 2 to 3). The heart was enlarged to percussion. A moderate degree of peripheral sclerosis was present. The blood pressure readings ranged from 140 systolic and 100 diastolic to 170 systolic and 105 diastolic, expressed in millimeters of mercury. The concentration of hemoglobin was 47 per cent; the blood urea amounted to 109 mg. per hundred cubic centimeters, and the urine had a specific gravity of 1.017. Albuminuria (grade 3), erythruria (grade 3), leukocyturia (grade 2) and casts (grade 2) were present. Ophthalmoscopic examination revealed a moderate grade of retinitis of the acute angiospastic type. The optic disks were mildly anemic and moderately edematous, with elevation measuring 2 D. The peripapillary retina was mildly edematous, and there was early macular star formation. Definite cotton wool patches and hemorrhages were present. No definite organic vascular changes were noted. Nine days later (September 13) ophthalmoscopic examination revealed that the optic disks were less edematous, with elevation of about 1 D., but that the edema was still spreading into the retinas along the vessels. Cotton wool patches were still present. No hemorrhages were noted. Sixteen days later the patient began to have convulsions, and she died on October 3, three days after the onset of convulsions.

This case is one in which an acute angiospastic type of retinitis developed, apparently following some type of infection, either influenza or the attack of "appendicitis." There was definite elevation of the blood pressure readings and of the concentration of blood urea on the patient's last admission, when the retinitis was present, and there was a diminution in the concentration of hemoglobin. It is difficult to say just what brought on the acute angiospastic episode. The patient had headache, dyspnea, edema and blurring of vision, so that it is likely that generalized involvement of the vascular system was present which resulted in elevation of the blood pressure readings and development of retinitis. These conditions probably occurred about the same time. The patient had visual disturbances for more than four months, and she died approximately five months after the onset of terminal symptoms. Since, on her last admission, macular stars were present and since these usually do not develop in the presence of retinitis of average severity until approximately six weeks after the onset, it would follow that she had had retinitis for at least six weeks before her admission. Retinitis improved under observation in spite of the general declining course of this patient.

In a certain number of cases of the acute angiospastic type there is a tendency toward spontaneous regression of retinitis in spite of the presence of increasing renal insufficiency with progression of the disease to a relatively rapid fatal termination. Retinitis with such a course was observed in 5 cases.

2. Retinitis Which Cleared Up Without Residual Changes in Retinas or Vessels: In 1 patient among those who had active acute angiospastic

retinitis, the retinitis cleared up completely without any residual changes in either the retinas or the vessels. Retinitis had appeared two months before the death of this patient. It was characterized by mild generalized arteriolar constriction and a mild grade of edema of the retina with a few hemorrhages. This retinitis was no longer present when the patient was seen a month later. The patient died of bilateral bronchopneumonia and empyema, however, two months after the appearance of the retinitis. The blood pressure readings were definitely higher when the retinitis was present than at the subsequent examination, when the retinas were normal. Also, the content of blood urea was normal at the time the retinitis developed, and the retinitis cleared up in spite of gradual elevation of the value for blood urea.

3. Retinitis Which Cleared Up but Left Residual Postspastic Arteriolar Lesions: In 2 additional patients active acute angiospastic retinitis cleared up, but definite residual sclerosis could be noted in the retinal arterioles. The patients were women aged 17 and 20 years, respectively. One had general edema and the other had none. The one who had edema died of myocardial insufficiency, but the concentration of blood urea was normal. Anemia and elevated blood pressure readings were present in both. The weight of the hearts in these 2 patients was greater than normal, and the combined weight of the kidneys was less than normal. In 1 patient retinitis had been observed ten months before death. It was characterized by slight sclerosis of the retinal arterioles of the postangiospastic or postretinitic type, pallor of the optic disks and retina and a few cotton wool patches and hemorrhages. There was no disturbance of vision. Retinitis had disappeared when the ocular fundus was examined thirteen days before death, but minimal structural changes in the arterioles remained. There was a progressive elevation in the values both for blood pressure and for blood urea before death occurred. In the other patient, according to the history, retinitis had occurred about twenty-two months previously during eclampsia, and there was blurring of vision at that time. When the ocular fundus was examined nineteen days before death of the patient, there were evidences of previous retinitis but no recent active lesion. Sclerosis (grade 2), which was noted in the retinal arterioles, was of the postangiospastic or postretinitic type.

Figure 4 *B* is a photomicrograph of a section of the kidney from a patient (case 47 in table 1) who had chronic glomerulonephritis and the acute angiospastic type of retinitis without chronic sclerosis of the retinal arterioles.

Acute Angiospastic Retinitis with Chronic Sclerosis of the Retinal Arterioles.—Two types of patients were encountered in this particular category: (1) 1 patient had retinitis simulating that of diffuse arteriolar

disease with hypertension of group 3 and (2) 7 patients had retinitis simulating that of diffuse arteriolar disease with hypertension of group 4.

1. Retinitis Simulating That of Diffuse Arteriolar Disease with Hypertension of Group 3: A man 61 years old was found on ophthalmoscopic examination to have, in addition to the usual retinal lesions, definite chronic sclerosis of the retinal arterioles but no measurable elevation of the optic disk. The retinal picture in this patient could not be distinguished readily from that in patients with diffuse arteriolar disease and hypertension (group 3). There was no subjective disturbance of vision. The duration of life of the patient after the development of retinitis was approximately ten months.

2. Retinitis Simulating That of Diffuse Arteriolar Disease with Hypertension of Group 4: In 7 patients, all males, ophthalmoscopic examination revealed, in addition to the usual retinal lesions of acute angiospastic retinitis, definite chronic sclerosis of the retinal arterioles and also measurable edema of the optic disk (fig. 4 *C*). Except for the anemic appearance of the fundi, this type of retinitis cannot readily be distinguished from that which occurs in diffuse arteriolar disease with hypertension of group 4 (malignant hypertension). By the taking into account of the histories of definite subjective disturbance of vision and the apparent duration of the retinitis, it was possible to determine the duration of the lives of these 7 patients after the onset of retinitis. This varied from six weeks to thirteen months, with a mean of five and seven-tenths months. The mean duration of life in this group was considerably longer than that in patients with acute angiospastic retinitis not complicated by chronic arteriolar sclerosis. When the mean duration of life after the onset of retinitis in these 7 patients is compared with the mean duration of life after the onset of visual disturbances in patients with retinitis and malignant hypertension, as given by Wagener,[21] it is seen that patients who had chronic glomerulonephritis complicated by diffuse arteriolar disease had a shorter life (five and seven-tenths months) after the onset of retinitis than did patients who had malignant hypertension (Wagener's series) after the onset of visual disturbances (thirteen months). On postmortem examination, the weight of the hearts of these 7 patients was greater than normal in 6 and normal in 1. Not all the kidneys were typically contracted; the combined weight of the kidneys was less than normal in 4 of the 7 patients and greater than normal in 2 (in 1 instance the weighing of the kidney was not satisfactory). The duration of the disease in each of the 2 patients with larger than normal kidneys was approximately four years. Microscopic examination of the kidneys of these 7 patients revealed changes

21. Wagener, H. P.: The Retinitis of Malignant Hypertension, Tr. Am. Ophth. Soc. **25**:349-380, 1927.

in the glomeruli typical of those caused by chronic glomerulonephritis, but in addition there was a marked degree of arteriolar thickening, or arteriolosclerosis.

Arteriolosclerosis was encountered to a lesser degree in the 1 case in which diffuse arteriolar disease with hypertension of group 3 was simulated (described immediately before the 7 cases just described). In 3 of the 31 cases of acute angiospastic retinitis not complicated by chronic sclerosis of the retinal arterioles, there was a moderate degree of renal arteriolosclerosis.

In the 8 cases in which diffuse arteriolar disease with hypertension was simulated, arteriolar changes were present also in other organs that were examined, namely, the heart, liver, pancreas and brain. These arteriolar changes, or arteriolosclerosis, had resulted in thickening of the arteriolar wall and narrowing of the lumen. Most observers are agreed that the most conspicuous renal lesions in essential hypertension are arteriolosclerosis (formation of hyalin under the endothelium of the afferent glomerular arterioles) and hyperplastic thickening of the elastic tissue of the intima of the walls of the small and medium-sized arteries. In 4 of the 8 cases in which diffuse arteriolar disease with hypertension was simulated, necrosis of the wall of the renal arterioles was observed. This necrosis, called necrotizing arteriolitis by Fahr,[22] was supposed to be characteristic of malignant hypertension. Bell and Clawson [12b] found, in cases of essential hypertension in which the patients died of rapidly developing uremia, evidence of arteriolitis in the arterioles of the glomeruli, with small infarcts, infarcted glomeruli and, rarely, glomerulitis. Klemperer and Otani [23] stated the belief that the glomerular changes are caused by ischemia and not by inflammation. In the cases of acute angiospastic retinitis without chronic sclerosis of the retinal arterioles in my series, a moderate degree of renal arteriolosclerosis was present in 3. Necrotizing arteriolitis was present in 1 of these 3 cases. Thus, the latter lesion may be found in cases of uncomplicated chronic glomerulonephritis, in cases of chronic glomerulonephritis with superimposed essential hypertension and most frequently in cases of so-called primary malignant hypertension. Keith, Wagener and Kernohan [10] stated that they did not believe that this lesion is specific for malignant hypertension; they wrote that it is rather a change that occurs in the arterioles because of insufficient nourishment and that it may therefore also occur in the presence of other diseases.

There is seen to be no relation in the presence of edema of the body, swollen kidneys, retinal edema and edema of the optic disks in this

22. Fahr, T.: Ueber Nephrosklerose, Virchows Arch. f. path. Anat. **226**: 119-178, 1919.

23. Klemperer, P., and Otani, S.: Studies on "Malignant Sclerosis" of the Kidneys (Fahr), Arch. Path. **8**:559-561 (Sept.) 1929.

group, since patients who had and patients who did not have edema of the body had both small and large kidneys, and edema of the optic disk and of the retina was present in every case. On the other hand, it is noted that palpable peripheral sclerosis, renal arteriolosclerosis and retinal arteriolosclerosis were present in all 8 patients. The heart was larger than normal in all but 1. The mean blood pressure reading was elevated in all patients and was higher in this particular group than in any of the other groups.

To illustrate chronic glomerulonephritis with superimposed diffuse arteriolar disease and hypertension, the following case is reported.

A boy 14 years old (case 50 in table 1) first entered the Mayo Clinic on May 24, 1922, because of an attack of acute appendicitis, for which he was treated surgically. At that time he gave a history of having had pneumonia three to four years previously, as well as many attacks of tonsillitis on different occasions. The blood pressure reading was 130 systolic and 90 diastolic, expressed in millimeters of mercury. Tenderness and rigidity were present in the right lower quadrant of the abdomen; otherwise the results of examination were normal. Urinalysis disclosed a specific gravity of 1.011. Albuminuria (grade 1) was present, and there were occasional erythrocytes and leukocytes.

The patient returned on Jan. 22, 1925; he had edema of the face and ankles and albuminuria, which had appeared after a head cold contracted a month previously. On examination, general edema (grade 2) was present, and the heart was enlarged to percussion. The mean blood pressure reading was 160 systolic and 110 diastolic, and the range was from 130 systolic and 90 diastolic to 170 systolic and 110 diastolic, expressed in millimeters of mercury. The concentration of blood urea was 36 mg. per hundred cubic centimeters, and the concentration of hemoglobin was 75 per cent. The serum proteins amounted to 4.8 Gm. per hundred cubic centimeters. The urine had a specific gravity of 1.007, and albuminuria (grade 1) was present. There were occasional granular casts. Erythruria (grade 1) and leukocyturia (grade 1) were present. The ocular fundi were essentially normal, but the retinal arterioles were slightly contracted. A diagnosis of subacute glomerulonephritis with anasarca was made, and the patient was treated by restriction of the diet and diuretic agents.

The patient returned on July 30 for a tonsillectomy. At this time he had albuminuria and erythruria.

He returned again for reexamination on May 27, 1927. Results of general and ophthalmoscopic examinations were normal. The blood pressure was 130 systolic and 90 diastolic, expressed in millimeters of mercury. The content of hemoglobin was 70 per cent and that of blood urea 47 mg. per hundred cubic centimeters. Urinalysis showed a specific gravity of 1.011, albuminuria, granular casts, erythruria (grade 1), leukocyturia (grade 1) and hyaline casts (grade 2). A diagnosis of chronic glomerulonephritis was made.

The patient again returned on Jan. 20, 1930, with the complaint of occipital headache, which he said had been present for the previous six weeks, failing vision of one month's duration and puffiness of the eyes, epistaxis, vomiting and drowsiness for the previous few days. Examination revealed a pale drowsy young man. The heart was enlarged to percussion, and there was palpable peripheral sclerosis (grade 2). The blood pressure readings ranged from 170 systolic and 120 diastolic to 210 systolic and 120 diastolic, expressed in millimeters of mercury. The concentration of hemoglobin was 60 per cent. The blood

urea amounted to 271 mg. per hundred cubic centimeters and increased to the terminal value of 657 mg. Urinalysis showed a specific gravity of 1.010, albuminuria (grade 2) and occasional leukocytes. Ophthalmoscopic examination revealed marked constriction of the arterioles, with sclerosis (grade 2) and retinitis (grade 3) of the malignant hypertensive type. The optic disks were hyperemic and edematous, with an elevation of 4 D. Subconjunctival ecchymosis was present in the left eye. The patient died on Feb. 1, 1930, twelve days after the last admission, of renal insufficiency. There was a decrease in blood pressure determinations to 155 systolic and 80 diastolic, expressed in millimeters of mercury, shortly before death. Photomicrographs of two sections from the kidney of this patient are seen in figure 5.

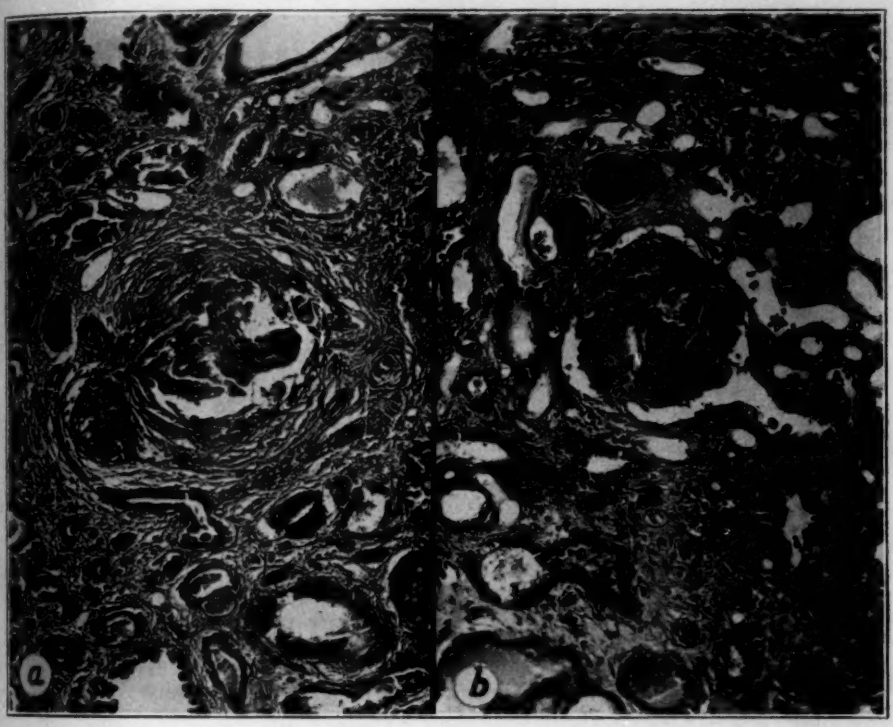

Fig. 5.—Sections of a kidney from a patient (case 50 on table 1) with chronic glomerulonephritis and superimposed diffuse arteriolar disease and hypertension (hematoxylin and eosin, × 150) showing (*a*) crescent formation in a glomerulus and thickening of the wall of the glomerular arterioles and (*b*) partial hyalinization of a glomerulus and marked thickening of the wall of the glomerular arteriole.

In this case of chronic glomerulonephritis with superimposed diffuse arteriolar disease and hypertension, the retinitis is to be interpreted as being, probably, an acute angiospastic episode of about four to six weeks' duration at the time of the patient's last admission superimposed on

chronic hypertensive sclerosis. This patient had visual symptoms of only a month's duration, and he died approximately six weeks after the onset of the retinitis, which simulated the retinitis associated with hypertension of group 4, or malignant hypertension, as described by Keith, Wagener and Kernohan.[10] It might be remarked that in cases such as this one, it is only by the history and the results of microscopic examination of the kidneys that the examiner can ascertain that chronic glomerulonephritis is present. Otherwise, if this patient had been seen only once (that is, only at the time of his last admission), it is possible that his condition would have been diagnosed as malignant hypertension.

Microscopic examination of the kidneys in this case (fig. 5) and in others of the same group (acute angiospastic retinitis with chronic sclerosis of the retinal arterioles) showed, in addition to the glomerular changes characteristic of chronic glomerulonephritis, marked arteriolosclerosis similar to that seen in kidneys in the presence of essential hypertension. Arteriolosclerosis was seen to a less extent in the case in which hypertension of group 3 was simulated. Examination of the arterioles in some of the other organs, such as the heart, liver, pancreas and brain, showed similar changes. These arteriolar changes have been mentioned by Keith, Odel, Morlock, Rosenberg and Kernohan [24] and by Rosenberg [25] in their studies dealing with arteriolar changes in various organs in the presence of essential hypertension.

PROGNOSIS IN THE VARIOUS GROUPS

On the basis of the history of definite subjective disturbances of vision and of the apparent duration of the retinitis, the length of life after the development of retinitis in the 46 patients in whom abnormal ocular fundi were observed could be determined fairly accurately before the death of the patients (10 of the total of 56 patients had normal ocular fundi until death). The mean duration of life of the 46 patients in the several groups is given in table 5.

On the basis of the data in table 5, a fairly accurate duration of life can be predicted for patients who have various types of retinitis. Certain additional factors (not shown in table 5) which influence life expectancy are of interest. It may be noted at this time that if an acute angiospastic type of retinitis without chronic sclerosis of the retinal arterioles is showing no tendency to regress, the prognosis is very grave. The probable duration of life in such a case would be approximately two months. However, if there is evidence of a tendency of the retinitis to regress,

24. Keith, N. M.; Odel, H. M.; Morlock, C. G.; Rosenberg, E. F., and Kernohan, J. W.: Pathologic Studies of the Arterial System in Severe Hypertension, Proc. Staff Meet., Mayo Clin. **14**:209-224 (April 5) 1939.

25. Rosenberg, E. F.: The Brain in Malignant Hypertension: A Clinicopathologic Study, Arch. Int. Med. **65**:545-586 (March) 1940.

then the duration of life may be much longer, from eight to sixteen months, and sometime in this period the retinitis may disappear.

If acute angiospastic retinitis is superimposed on previously sclerosed retinal arterioles and if edema of the optic disk is present, the probable duration of life of the patient so affected would be about five and seven-tenths months. Patients with malignant hypertension in which the same retinal picture is present live much longer. Wagener found the average duration of life after the onset of visual disturbances in a series of patients who had malignant hypertension to be thirteen months. This figure (thirteen months) may be partly explained by the fact that marked renal damage and impairment of renal function are present in cases of primary chronic glomerulonephritis, which usually are not present in cases of malignant hypertension at the time of onset of retinitis.

If edema of the optic disk is not present, the duration of life may be a little longer than it would be if such edema were present. In the case in the present series in which the patient had retinitis simulating

TABLE 5.—*Mean Duration of Life After Development of the Retinitis*

Type of Retinitis	Cases	Mean Duration of Life, Months
Retinitis of anemia	7	3.2
Acute angiospastic retinitis without chronic sclerosis of retinal arterioles	31	4.0
Acute angiospastic retinitis with chronic sclerosis of retinal arterioles (retinitis of diffuse arteriolar disease with hypertension)	8	6.2
Total cases	46	4.3

that of diffuse arteriolar disease with hypertension of group 3 but did not have edema of the optic disks, the duration of life was ten months. The statistical value of the length of life of this single patient is not great, but it may be compared to the longer expectancy of life of patients with severe primary hypertension of group 3.

Of the 31 patients with the acute angiospastic type of retinitis *without* chronic sclerosis of the retinal arterioles, evidences of regression were observed in 8. Thus, 23 patients, or the majority, died in the acute angiospastic phase of the disease, and the rest died while the retinitis was regressing or after the retinitis had disappeared. On the other hand, all 8 of the patients with acute angiospastic retinitis *with* chronic sclerosis of the retinal arterioles had actively progressing retinitis.

It was pointed out previously that 7 patients had an anemic type of retinitis. Five of these patients died with this type of retinitis, and it should be noted that the duration of life of these 5 was very short, the mean being only two weeks. However, 2 of the 7 patients had had transient retinitis of the anemic type three and seventeen months, respectively, before they succumbed. It is probable that the appearance in the

retina of hemorrhages of the anemic type has no definite prognostic significance. It is, of course, impossible to prognosticate for the 10 patients (of the 56 in the study) who had normal ocular fundi.

COMPARISON OF MY STATISTICS WITH THOSE OF OTHER OBSERVERS

It is rather difficult to compare statistics of the present series with statistics of other series mentioned in the literature, because of several differences. In the first place, a somewhat different classification of retinitis is used by other authors. In addition, the other series in the literature include data concerning living patients as well as information obtained at necropsy. This makes possible two errors:

First, the diagnosis of chronic glomerulonephritis could not have been made definitely in every case if some patients had still been alive at the time of diagnosis. Since some patients have no history of acute nephritis, they may be suffering from either chronic glomerulonephritis or essential hypertension, and the diagnosis cannot be considered conclusive until sections of the kidneys have been examined microscopically.

Second, the ocular fundic picture may change before death of the patient occurs. It was noted in the present series that in some patients retinitis developed on subsequent examination and that in other patients retinitis previously present completely disappeared before death. Therefore, the relation of the time of the ophthalmoscopic examination to the time of death is important.

In the series of 55 patients with chronic glomerulonephritis reported by Fishberg and Oppenheimer,[26] 24 patients had normal ocular fundi, 14 had retinal arteriosclerosis and arteriosclerotic retinopathy and the remaining 17 had a malignant hypertensive type of retinitis. Mention was made of 20 deaths in this series.

Cannady and O'Hare,[19] in a series of 32 cases in which postmortem examination was done in 21 cases, observed normal ocular fundi in 2 cases, retinal arteriolar sclerosis in 5, arteriosclerotic retinopathy in 11 and hypertensive retinitis in 14.

It is seen, then, that the incidence of retinitis and normal ocular fundi varies markedly in different series, and the variation in such series probably depends, as suggested earlier in the paper, on the time which elapses between the last ophthalmoscopic examination of the patients and their deaths.

It should be remembered that in the present series of 56 cases diagnosis was made at necropsy. In a separate series of 50 cases [27] a clinical

26. Fishberg, A. M., and Oppenheimer, B. S.: The Differentiation and Significance of Certain Ophthalmoscopic Pictures in Hypertensive Diseases, Arch. Int. Med. **46**:901-920 (Dec.) 1930.

27. Wagener, H. P.: Personal communication to the author.

diagnosis of chronic glomerulonephritis was made. In this series the patients were examined at the Mayo Clinic but did not die during the period of observation, and an entirely different incidence of the various retinal findings was noted (table 6).

In the cases in which the diagnosis was made clinically ocular fundi were normal in 17 (34 per cent, as compared with only 17.8 per cent in the present series of 56 cases). In 4 of the cases (8 per cent) in which the diagnosis was made clinically hemorrhages of the anemic type were present in the retina (12.5 per cent in the present series). In 16 of the cases (32 per cent) in which the diagnosis was made clinically, the retinal arterioles exhibited a definite grade of arteriolosclerosis, but retinitis was not present (no similar conditions in the present series). In 9 of the cases (18 per cent) in which the diagnosis was made clini-

TABLE 6.—*Comparative Incidence of Retinal Observations in Fifty Cases of Chronic Glomerulonephritis in Which Diagnosis Was Clinical and in Fifty-Six Cases (Present Study) in Which Diagnosis Was Made at Necropsy*

		Lesions of Retina									
		None		Retinitis of Anemia		Sclerosis Only		Retinitis of Diffuse Arteriolar Disease		Acute Angiospastic Retinitis	
Glomerulonephritis	Number of Cases	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
Diagnosed clinically	50	17	34	4	8	16	32	4	8	9	18
Diagnosed at necropsy	56	10	17.8	7	12.5	..	..	8	14.2	31	55.3

cally, acute angiospastic retinitis without chronic sclerosis of the retinal arterioles was present (55.3 per cent in the present series). In 4 of the cases (8 per cent) in which the diagnosis was made clinically, retinitis simulating that of diffuse arteriolar disease with hypertension was present (14.2 per cent in the present series).

It is rather difficult to explain the presence of retinal arteriolosclerosis in 40 per cent of the cases in which the diagnosis was made clinically (this figure includes the cases in which sclerosis only was present and those in which superimposed retinitis was present) when it was observed in only 14.2 per cent of the cases of the present series, in which diagnosis was made at necropsy. A possible explanation is that in some of the cases in which the diagnosis of chronic glomerulonephritis was made clinically (table 6) the diagnosis would have been proved at necropsy to be incorrect.

Table 5 and the explanatory text show that the duration of life after the onset of retinitis may vary from a minimal mean of two weeks to a maximal mean of sixteen months. The maximal duration of life in any

case was twenty-two months. The mean duration of life in the entire series of 46 cases in which retinitis of some type was present was four and three-tenths months (table 5). If, on the other hand, the present series of 56 cases in which diagnosis was made at necropsy were combined with the series of 50 cases in which the diagnosis was made clinically, the mean duration of life in those in which death occurred would be four and eight-tenths months. These figures closely approximate those of Cannady and O'Hare, which were twenty-three months for the maximal duration of life after the appearance of retinitis and a mean duration of life of six and three-tenths months for the whole group.

Moore [7] observed very few patients with nephritis and retinitis who lived for two years. In 1884 Michel [28] stated that the majority of patients suffering from granular kidneys complicated by the presence of retinitis died within one and one-half years.

Friedenwald [29] and Cannady and O'Hare [19] and others have come to the conclusion that there seems to be no distinctive type of retinal lesion in chronic glomerulonephritis. In the present series, it is evident that the most characteristic retinal picture in uncomplicated chronic glomerulonephritis is that of acute angiospastic retinitis without chronic sclerosis of the retinal arterioles. It occurred in 31 (55.3 per cent) of the 56 cases in the complete series and in 31 (67.4 per cent) of the 46 cases in which retinitis of any type was present. When it did occur, it usually, although not always, ushered in the terminal phase of the disease.

PROBABLE OR POSSIBLE GENERAL PATHOGENESIS OF RETINITIS OF CHRONIC GLOMERULONEPHRITIS

There have been many theories advanced as to the probable pathogenesis of the retinitis which occurs in chronic glomerulonephritis. None of the general or local factors suggested by various authors as causes of this type of retinitis have been shown conclusively to be present in all cases of chronic glomerulonephritis accompanied by active retinitis and to be absent in all cases of chronic glomerulonephritis in which retinitis is absent. Objections can be raised to the validity of the nitrogen retention theory of Opin and Rochon-Duvigneaud [30] and of

28. Michel, J.: Lehrbuch der Augenheilkunde, Wiesbaden, J. F. Bergmann, 1884.

29. Friedenwald, J. S.: The Pathology of the Ocular Changes in Nephritis and Hypertension, in Berglund, H.; Medes, G.; Huber, G. C.; Longcope, W. T., and Richards, A. N.: The Kidney in Health and Disease, in Contributions by Eminent Authorities, Philadelphia, Lea & Febiger, 1935, pp. 638-664.

30. Opin and Rochon-Duvigneaud: Lésions comparées de la rétine et des autres organes chez les malades atteints de rétinite brightique: Indications qu'elles fournissent sur la pathologénie de l'affection, Arch. d'opht. **24**:155-176, 1940.

Widal, Morax and Weill,[31] to the hypothetic toxin of Koyanagi,[32] to the role of local arteriosclerosis and arteriolosclerosis as advanced by Carl,[33] of Bavaria, Michel,[28] Cohen,[34] Verwey,[35] Kyrieleis[36] and Friedenwald[29] and to the ischemic theory of Schieck and Volhard.[37] Detailed consideration of the various theories extant will not be attempted. Suffice it to say that at present some form of the theory of the vasospastic or ischemic origin of the retinitis seems to be the most attractive. Angiospasm has been shown to occur clinically in the retina in various forms of hypertension by Haselhorst and Mylius,[38] Wagener,[39] Masters,[40] Hallum,[41] Zeeman,[42] Friedenwald[29] and others;

31. Widal, F.; Morax, V., and Weill, A.: Rétinite albuminurique et azotémie, Ann. d'ocul. **143**:354-358, 1910.

32. Koyanagi, Y.: Ueber die Pathogenese der Retinitis nephritica, Klin. Monatsbl. f. Augenh. **80**:436-461 (April 27) 1928; Veränderungen an der Netzhaut bei Hochdruck: Pathologische Anatomie, Tr. Internat. Ophth. Cong. (1937) **1**:143-283, 1938.

33. Carl, A., cited by Friedenwald.[29]

34. Cohen, M.: (*a*) Significance of Pathologic Changes in Fundus in General Arterial and Kidney Diseases, J. A. M. A. **78**:1694-1701 (June 3) 1922; (*b*) personal communication to the author.

35. Verwey, B. C. de la F.: Ueber die Arteriosklerose der Netzhaut und ihre Bedeutung für die Genese der Retinitis albuminurica, Klin. Monatsbl. f. Augenh. **79**:148-158 (Aug.) 1927.

36. Kyrieleis, W.: Ueber die Arteriolosklerose von Netzhaut, Aderhaut und Sehnerv sowie ihre Bedeutung für die Pathogenese der Retinitis albuminurica, Arch. f. Augenh. **103**:161-198 (June) 1930.

37. Schieck, F., and Volhard, F.: Netzhautveränderungen und Nierenleiden, Zentralbl. f. d. ges. Ophth. **5**:465-470, 1921. Volhard, F.: Die Pathogenese der Retinitis albuminurica, ibid. **21**:129-136 (March 5) 1929.

38. Haselhorst, G., and Mylius, K.: Zur Frage der Gefässkrämpfe bei Eklampsie, Zentralbl. f. Gynäk. **52**:1180-1189 (May 12) 1928. Mylius, K.: Funktionelle Veränderungen am Gefäss-system der Netzhaut, Abhandl. a. d. Augenh. **10**:1-82, 1928.

39. Wagener, H. P.: Arterioles of the Retina in Toxemia of Pregnancy, J. A. M. A. **101**:1380-1384 (Oct. 28) 1933; Lesions of the Optic Nerve and Retina in Pregnancy, ibid. **103**:1910-1913 (Dec. 22) 1934; The Retinal Lesions in Nephritis and Hypertension, in Berglund, H.; Medes, G.; Huber, G. C.; Longcope, W. T., and Richards, A. N.: The Kidney in Health and Disease, in Contributions by Eminent Authorities, Philadelphia, Lea & Febiger, 1935, pt. 5, chap. 37, pp. 622-637; Clinical Interpretation of Retinal Vascular Lesions in Hypertension and Nephritis, Pennsylvania M. J. **40**:705-711 (June) 1937. Wagener, H. P.; Barker, N. W., and Burke, C. F.: Acute Angiospastic Retinitis: Occurrence in Cases of Severe Hypertensive and Renal Disease, Am. J. M. Sc. **185**:517-528 (April) 1933. Wagener, H. P., and Keith, N. M.: Diffuse Arteriolar Disease and Hypertension, Tr. Internat. Ophth. Cong. (1937) **1**:1-86, 1938.

40. Masters, R. J.: Routine Ophthalmoscopic Examination as Aid in Management of Maternity Cases, Tr. Am. Ophth. Soc. **31**:416-450, 1933.

(Footnotes continued on next page)

and elevation of blood pressure invariably is present in cases of chronic glomerulonephritis accompanied by retinitis except in the few instances in which the retinal lesions depend on anemia.

CLINICAL CONSIDERATION OF THE ROLE PLAYED BY HYPERTENSION

In the clinical examination of patients who have chronic glomerulonephritis, the physician often receives the impression that the onset of retinitis is more or less intimately associated with an increase of diastolic blood pressure. It is somewhat difficult to substantiate this impression by a statistical study of readings of mean blood pressure obtained during hospital observation of such patients. The general tendency of the blood pressure to reach higher values among patients who have retinitis is clearly demonstrated, however, by the following facts:

1. Of the 12 patients in whom the ocular fundi were normal at death (normal constantly in 10 and normal at death in 2 who had had hemorrhages previously), 4 patients had had normal blood pressure at all times, and 8 had had some elevation of the blood pressure at some time during their observation. Four had elevation of both systolic and diastolic pressures; 3 had elevation of systolic pressure only, and 1 had elevation of diastolic pressure only. In only 7 patients was the diastolic pressure more than 90; in only 5 was it more than 100, and in only 2 was it more than 110, expressed in millimeters of mercury.

2. All 5 of the patients who died in the presence of retinitis of the anemic type had had elevated blood pressure at some time during life. In 1 there was elevation of the systolic blood pressure only; in only 3 was the diastolic blood pressure more than 100, and in only 1 was it more than 110, expressed in millimeters of mercury.

3. All of the 31 patients who died in the presence of an acute angiospastic type of retinitis without chronic sclerosis of the retinal arterioles had had elevated blood pressure during life. In all of them the diastolic pressure advanced to 100 or more; in 22, 17 and 8 of them it advanced to 110, 120 and 130 or more, respectively, expressed in millimeters of mercury.

4. All of the 8 patients who died in the presence of an acute angiospastic retinitis of the type seen in diffuse arteriolar disease with hypertension had had diastolic blood pressure which advanced to 100 or more.

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41. Hallum, A. V.: Eye Changes in Hypertensive Toxemia of Pregnancy: A Study of Three Hundred Cases, J. A. M. A. **106**:1649-1651 (May 9) 1936; Eye Changes in the Management of Hypertensive Toxemia of Pregnancy: A Five-Year Study, South. M. J. **31**:64-67 (Jan.) 1938.

42. Zeeman, W. P. C.: Personal communication to the author.

In 7, 6 and 4 of the cases, the diastolic pressure advanced to 110, 120 and 130 or more, respectively, expressed in millimeters of mercury.

Among the patients in whom retinitis developed while they were under observation, blood pressure was much higher when retinitis was present than it had been previously when the ocular fundi were normal. This was true in 9 patients in whom an acute angiospastic type of retinitis without chronic sclerosis of the retinal arterioles developed and in 2 with acute angiospastic retinitis in whom diffuse arteriolar disease with hypertension was simulated.

Eleven patients who had acute angiospastic retinitis without chronic sclerosis of the retinal arterioles and 4 who had acute angiospastic retinitis which simulated that of diffuse arteriolar disease with hypertension were seen only once, but each one gave a history of having had hypertension longer than retinitis. In 2 patients in whom retinitis disappeared while they were under observation, the blood pressure gradually decreased, although it remained above normal.

Cannady and O'Hare found hypertension to be the most common factor preceding or accompanying retinal changes, and their 2 patients who had normal ocular fundi had normal blood pressure.

It was not possible to determine the duration of hypertension among the patients in the present series who had normal ocular fundi and an anemic type of retinitis.

In a comparison of the 31 cases of purely acute angiospastic retinitis with the 8 cases of retinitis in which diffuse arteriolar disease with hypertension (groups 3 and 4) was simulated, it is seen that the duration of hypertension is much shorter in the first group. That the development of chronic hypertension and of diffuse arteriosclerosis is related somewhat to the duration of the disease is suggested by the fact that the mean duration of life after the onset of the nephritis in the cases in which data were available relative to survival was thirteen months in the former group and five plus years in the latter. The range is rather variable, with a maximal duration of life of four years in cases of acute angiospastic retinitis and fifteen years in cases of retinitis which simulated that of diffuse arteriolar disease.

RELATION OF ARTERIAL HYPERTENSION TO RENAL ARTERIOLOSCLEROSIS

There seems to be some relation between arterial hypertension and renal arteriolosclerosis in these cases. In the patients with purely acute angiospastic retinitis either there were no renal arteriolar changes or there was minimal renal arteriolosclerosis. These patients had had hypertension and retinitis for a variable but usually short period before death. In the group in which the retinitis simulated that of diffuse arteriolar disease with hypertension, a definite degree of renal arteriolo-

sclerosis was present, and also hypertension and retinitis had been present in these patients for longer periods than they had been present in the former group. It may be that in the patients with acute angiospastic retinitis hypertension had not been present long enough for arteriolar changes or arteriolosclerosis to occur in the vessels of the body, such as the vessels of the kidney and retina. In cases in which hypertension had been present for relatively long periods, arteriolosclerosis was rather pronounced, as noted in sections of the kidneys and in the retinas.

Renal arteriolosclerosis was observed to be marked in all 8 of the cases in which an acute angiospastic type of retinitis simulated the retinitis of diffuse arteriolar disease with hypertension (groups 3 or 4). In the group of cases in which a purely acute angiospastic type of retinitis was present, in either the active or the residual phase, the renal arterioles were noticeably involved in only 3 cases. It may be that renal ischemia was involved in the first-mentioned group of cases, because of the lessened blood supply resulting from organic arteriolar changes. What part the renal ischemia plays in such instances it is hard to say. It may be responsible for the higher elevation of blood pressure in cases of chronic glomerulonephritis and retinitis simulating the retinitis of diffuse arteriolar disease with hypertension. Renal ischemia may be a factor in the production of a nephrotoxin or some other vasopressor substance which may be responsible for both the occurrence of retinitis and the elevation of the blood pressure, as suggested by Goldblatt [43] and by Keyes and Goldblatt.[44]

SUMMARY AND CONCLUSIONS

The most characteristic retinal picture observed in 56 cases proved by necropsy to be instances of definite chronic glomerulonephritis was an acute angiospastic type of retinitis without evidence of chronic sclerosis of the retinal arterioles. It occurred in 55 per cent of the 56 cases studied and in 67 per cent of the 46 cases in which retinitis of any type was present.

In the cases in which renal arteriolosclerosis was present, the blood pressure was definitely higher, and remained so for a longer time, and the palpable peripheral sclerosis was of higher grade than in the uncomplicated cases. A similar change in the arterioles was observed in other organs in cases in which marked renal arteriolosclerosis was present. Necrosis of the renal arterioles was observed in only half the cases in

43. Goldblatt, H.: Experimental Hypertension Induced by Renal Ischemia, in Harvey Lectures, 1937-1938, Baltimore, Williams & Wilkins Company, 1938, pp. 237-275.

44. Keyes, J. E. L., and Goldblatt, H.: Experimental Hypertension: IV. Clinical and Pathologic Studies of the Eyes; a Preliminary Report, Arch. Ophth. **17**:1040-1054 (June) 1937.

which renal arteriolosclerosis was present and was observed also in the renal arterioles in a case in which the purely acute angiospastic type of retinitis was present.

The following conclusions may be based on the results of the present study:

1. When nephritis is complicated by a marked degree of sclerosis of the renal arterioles, a demonstrable degree of chronic sclerosis will be present in the retinal arterioles, in addition to retinitis.

2. The onset of retinitis of a purely acute angiospastic type without chronic sclerosis of the retinal arterioles, such as was seen in 31 (55 per cent) of this series of 56 cases of chronic glomerulonephritis, is an extremely grave prognostic sign, since the mean subsequent duration of life of the patient who has such retinitis will be only four months. In substantiation of this conclusion, it may be observed that no patient in the group of 31 who had such retinitis in the present series lived more than twenty-two months after the retinitis first developed.

3. Although blood pressure may be elevated in a certain number of patients with chronic glomerulonephritis who do not have retinitis, in the main the blood pressure readings of patients with retinitis will be higher at or near the time of the onset of the retinitis than those of glomerulonephritic patients in whom retinitis does not develop.

4. Of the various factors to be considered in cases of chronic glomerulonephritis with retinitis, hypertension and arteriolar constriction or spasm seem to be the most potent in the production of retinal lesions.

5. Retinal observations in cases of chronic glomerulonephritis will vary considerably, depending on the phase of the disease at the time the ophthalmoscopic examination is made. The process in the retina is a dynamic and not a static one. Retinitis may develop a considerable time before death of the patient and may persist throughout the course of the disease; in some instances it may regress or disappear; in others it may appear only in the terminal stage. In some cases no retinal abnormalities will be apparent at the time of death of the patients; in such cases the possibility is either that retinitis had been present in an earlier phase and had subsequently cleared up or that retinitis never had occurred throughout the course of the disease.

LIGHT THRESHOLD

ITS CLINICAL EVALUATION

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The terms minimum visible, light threshold and minimum light visible are synonymous and signify the least intensity of light visible to the eye, in other words, the ability of the eye to adapt itself to darkness. Physiologically, dark adaptation, or the light threshold, is a function of the cruder retinal elements, namely, the rods and the visual purple, in contradistinction to light adaptation, a function of the more refined and sensitive cone elements.

The subject of dark adaptation was first brought to the attention of the medical world through the work of Aubert [1] in 1862. Since then the problem has attained a more scientific level by standardization of the light intensity in the testing device, as well as of its calibration. Within recent years the subject of dark adaptation has become increasingly important, owing to the work of Wald,[2] who observed that the visual purple in the eyes of animals bleached out by light is assisted in its regeneration by vitamin A.

Pathologic changes in light threshold (pathologic dark adaptation) may be of any of three types: type 1, in which the anatomic structure is interfered with, as in choroiditis and retinitis pigmentosa; type 2, in which the physiologic function is interfered with, as in avitaminosis A, and type 3, in which there is night blindness without any determined cause, the so-called idiopathic type. Often it is found, after close study, that a patient with the so-called idiopathic type is actually suffering from an avitaminosis A and the adaptation should be classed as type 2.

Dark adaptation may be studied in one of two ways: by either the qualitative or the quantitative method. The qualitative test is useful when large groups are to be examined. With this method only a single light threshold is taken. With the quantitative test, however, a number of thresholds are taken at fixed minute intervals in succession and usually for a period of thirty minutes. It is generally conceded that the light threshold obtained after one-half hour usually remains constant there-

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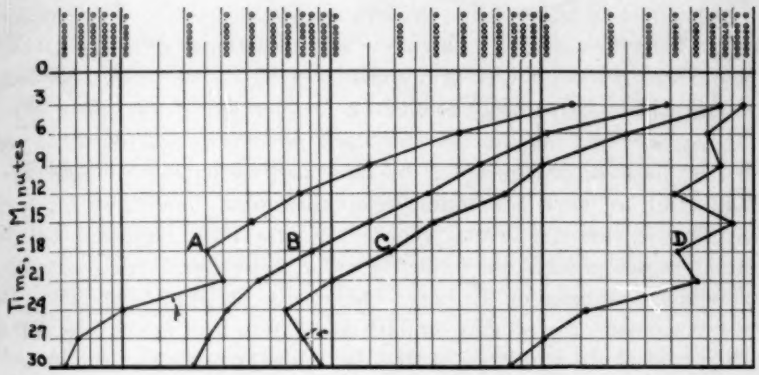
Read before the New York Academy of Medicine, Section of Ophthalmology, on Jan. 20, 1941.

1. Aubert, H.: Ann. d. Physiol. u. Chem. **115**:87, 1862.
2. Wald, G.: J. Gen. Physiol. **18**:905, 1934; Nature, London **132**:316, 1933.

after. In a quantitative study of dark adaptation the first threshold is high, decreasing at each successive test. When threshold studies are made every minute or fraction thereof after preexposure to light, one can easily separate the cone from the rod function.

When the entire series of thresholds are plotted, they form a hyperbolic curve (chart, *A*). Interruption in the smoothness of the curve denotes either inattention (chart, *A-a*) on the part of the patient or a pathologic condition (chart, *C-b*). The taking of a series of thresholds, therefore, gives this subjective test objective qualities. When a dark adaptation study is immediately repeated, a normal threshold, through added experience, remains the same or even better. When the dark adaptation study is repeated after a pathologic result has been obtained, the thresholds are more abnormal than in the original test. This can be



Types of dark adaptation graphs: *A*, a normal curve. The rise in the threshold at twenty-one minutes and the immediate descent of the curve at twenty-four minutes (*a*) indicate inattention on the part of the patient. *B*, type of curve obtained in a case of vitamin deficiency. *C*, type of curve often noted in cases of glaucoma in which the dark adaptation is pathologic. The rise in the curve at twenty-seven minutes and the increase to thirty minutes (*b*) indicate fatigue and pathologic changes in the light threshold. *D*, the characteristic curve of retinitis pigmentosa, in which it will be noted that the greatest number of thresholds taken up to twenty-one minutes are above 0.025000 photon (cone function).

accounted for by the fact that an eye not functioning normally fatigues easily.

In the determination of dark adaptation, it is essential with any instrument employed that the quality of the light, regardless of its alteration in intensity, remain the same throughout the entire test. This means that use of a rheostat to alter the light is not permissible. Also the light to which the subjects are exposed in the threshold studies must be constant for all patients examined. Added refinements in a machine are, of course, portability, ease of operation and noiselessness.

As to the patient, a preliminary ophthalmoscopic examination is necessary before light threshold studies are begun. This aids in the classification of the pathologic thresholds, separating those due to ocular disease from the other types.

Avitaminosis in disease has been studied by many investigators. Through my association with an internist [3] and a urologist,[4] I was able to perform a number of dark adaptation studies of patients with a variety of diseases. It was consistently found that curves of dark adaptation showing slight pathologic changes were associated with calculi of the renal tract; slightly more pronounced pathologic changes were observed in cases of thyrotoxicosis, and still more pronounced pathologic changes were observed with hepatic diseases such as toxic hepatitis due to neoarsphenamine and cirrhosis of the Laennec type. In my study of over 5,000 patients with medical and surgical diseases I found a large number who did not show any change in dark adaptation. About 5 per cent of those patients whose dark adaptation was pathologic were night blind. In some cases the clinical symptoms as well as the night blindness improved with massive doses of vitamin A given hypodermically. Needless to say, no renal calculus was dissolved, nor were colds positively prevented by massive dosage either by mouth or by hypodermic injection.

The study of dark adaptation in ophthalmology has taken up much of my time in the past several years. My experience has been that the threshold is not affected by refractive error, color blindness, nystagmus, amblyopia ex anopsia or syphilis. Ordinarily the threshold is slightly higher in women. My studies on dark adaptation lead me to believe that the threshold of the right eye is slightly higher than that of the left eye. Some patients with high myopia have slightly pathologic dark adaptation.

Night blindness of the idiopathic type is not a very rare condition. Patients with this condition always present a high or pathologic threshold; the degree of the changes varies, however, and the plotted graph is not characteristic for this condition. In fact, it is not always possible in a case of pathologic dark adaptation to determine from the graph whether or not the patient is or is not night blind. Among the many patients whom I examined, some of those with the most pathologic dark adaptation graphs associated with hepatic disease—approaching in some cases the typical graph of retinitis pigmentosa—were not night blind, while others, with for example renal calculi, whose pathologic

3. Wohl, M. G., and Feldman, J. B.: J. Lab. & Clin. Med. **25**:485, 1940; Endocrinology **24**:389, 1939.

4. Ezickson, W. J., and Feldman, J. B.: Signs of Vitamin A Deficiency in Eye Correlated with Urinary Lithiasis: Report of Clinical Studies and Investigations on Twenty-Five Patients, J. A. M. A. **109**:1706 (Nov. 20) 1937; Urol. & Cutan. Rev. **43**:302, 1939.

changes were mild, had night blindness. The problem is still further complicated by the fact that some persons are not aware of their night blindness.

Dr. Ezickson and I had an interesting experience. The state police permitted us to do threshold studies on 75 persons arrested for having been involved in serious motor vehicle accidents.[5] Those subjects who had normal thresholds had three times as many accidents during the day as those whose light thresholds were pathologic. These accidents may have been due to such causes as fatigue, poor judgment and intoxication. The same causes could be held accountable for some of the night accidents. However, night blindness must be an important factor in the causation of night accidents, since the persons with pathologic thresholds had twice as many accidents at night as did those with normal thresholds.

One of the largest transportation companies did dark adaptation studies on 50 of their drivers immediately after a holiday season. All the drivers who had imbibed alcoholic drinks rather freely had a high threshold. This observation aids in corroborating the results of the investigation done at the Philadelphia General Hospital,[3] where 10 persons addicted to alcohol who were about to be discharged from the psychopathic ward had their dark adaptation determined. They were cooperative, and I was easily able to do threshold studies on them. Their dietary regimen prior to admission was poorly balanced and inadequate especially in vitamins A and B. A few were temporarily night blind. Each patient, without exception, had dark adaptation which was pathologic.

Some of my experiences with ocular conditions which are worthy of mention in respect to dark adaptation include a study of 31 patients with retinal arteriosclerosis, of whom all but 3 had pathologic dark adaptation.

With respect to choroiditis, in a group of 40 patients examined, all but 2 with very small areas of localized choroiditis had pathologic dark adaptation.

As to cases of sympathetic ophthalmia in which there was a questionable involvement of the remaining eye, in the several cases in which examinations were made the good eye always had a high pathologic threshold. When the offending eye was removed, however, the dark adaptation returned to normal.

With glaucoma I found that dark adaptation bore some relation to the visual field, little to the tension and none to the vision, except in the cases of severe glaucoma, in which, of course, all of these were affected. In a group of 130 cases of glaucoma, I found normal adaptation in 10. A similar experience was reported by Casten and Shaad[6] in a review

5. Feldman, J. B.: Indust. Med. **9**:158, 1940.

6. Casten, V., and Shaad, D. J.: Diagnostic Value of Tests of Light Sense in Early Glaucoma, Arch. Ophth. **9**:52 (Jan.) 1933.

of some of the original cases of Derby and Waite. It was felt by some observers that the thresholds were normal in these cases, because the light threshold studies did not include the area where the intraocular pressure would be thought to be most exerted. This I do not believe to be true, because in my studies of some of the cases I used a movable sector (light target). This enabled me to do threshold studies of the area of the retina where the fields were cut. Yet, in spite of this precautionary measure, the threshold was normal in a few of the 10 aforementioned cases of glaucoma in which this procedure was attempted. It is interesting that in cases in which the glaucoma is associated with a normal threshold a normal value for blood cholesterol is most likely to be found.

For postoperative prognosis of glaucoma, threshold studies may be found valuable. If the operation is successful the threshold should be almost normal at thirty minutes and should remain so, even if the dark adaptation study is continued for another half-hour. However, when the operation is not so successful each succeeding threshold after the first half-hour becomes increasingly higher, until almost within an hour of dark adaptation the pathologic threshold which the patient had prior to operation is attained.

I have noted bizarre graphs with alternating high and low thresholds—always pathologic, however—in cases of such diseases as Paget's disease, cerebrospinal syphilis and, sometimes, serious arteriosclerosis complicated by cardiac asthma.

In cases of retinitis pigmentosa the highest type of pathologic changes in dark adaptation are observed, regardless of the degree of retinal involvement; in fact, the changes are so pronounced that the graph may be said to be characteristic for this condition. Apropos of this, an interesting case is worthy of mention. It was important for a man with this condition to know if his 6 year old son was similarly afflicted. The boy's vision, fields and fundi were normal, but the dark adaptation study showed the characteristic graph of retinitis pigmentosa. The diagnosis was confirmed months later by both ophthalmoscopic and perimetric studies.

As to the effect of vitamin A therapy on retinitis pigmentosa, I may say that massive doses (50,000 U.S.P. units) were given intramuscularly daily for several months to a number of patients, without any effect.

In conclusion, I should like to state that dark adaptation is essentially an ophthalmologic problem. While the ophthalmologist is indebted to the physiologist and to the biochemist for its investigation, only the ophthalmologist can clinically evaluate its true merit. The qualitative test is helpful when large groups are to be examined. When, however, intensive study of a particular type of disease is desired, the quantitative

test should be utilized. In the latter type of study a number of thresholds are taken at definite intervals for about a half-hour.

Of the large number of patients with the variety of diseases examined, consistent pathologic dark adaptations were usually observed in those with renal calculi, thyrotoxicosis and certain types of hepatic diseases. With a large number of diseases, threshold studies were valueless.

In ophthalmology, a pathologic dark adaptation is observed often in cases of glaucoma; but there are exceptions, and for this reason this observation is not valuable at present as a diagnostic measure in the so-called preglaucoma stage. However, the dark adaptation test may be found useful in the prognosis when operation has recently been performed for glaucoma or when sympathetic ophthalmia is suspected. There appears to be some linkage between glaucoma, dark adaptation and blood cholesterol. It is hoped that with more intensive study of the subject of dark adaptation and its association with results of laboratory investigation, a solution to this interesting problem may be obtained.

Finally, with regard to a number of cases of night blindness of the true idiopathic type, in these cases the dark adaptation is pathologic but the plotted graph is not always characteristic for the condition. A more intensive study of this particular entity may aid in solving a grave problem, which is costing the lives of many persons both in war and in peace.

37 South Twentieth Street.

DISCUSSION

DR. ARTHUR ALEXANDER KNAPP: Since vitamin D has been reported to be of value in dark adaptation, I should like to ask whether Dr. Feldman has tried to improve the conditions of patients who have defective dark adaptation with vitamin D and calcium.

DR. CLYDE E. MCDANNALD: Dr. Feldman spoke of light adaptation as higher in the right eye than in the left. I should like to ask whether he correlated this finding with the righthandedness of lefthandedness of the patients.

DR. JACOB B. FELDMAN: This subject has been studied for nine years, and I believe that vitamin D and calcium may be of value. I have given vitamin A particularly for its effects ophthalmologically, but I did not find it of much value. However, in cases of idiopathic night blindness it did have value. I gave vitamin A for a long time, some patients taking 50,000 U.S.P. units every day for from ten to twelve weeks.

My studies on light adaptation were not associated with differential manual dexterity.

DISTRIBUTION OF SULFANILAMIDE AND ITS DERIVATIVES BETWEEN BLOOD AND AQUEOUS

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There are abundant reports in the literature suggesting that sulfanilamide and its derivatives may revolutionize therapy in ophthalmology as they have in general medicine. It is the purpose of this study to investigate the diffusion of various sulfanilamide compounds into the eye, to evaluate the importance of paracentesis as a means of raising the level of the drug in the aqueous and to determine the correlation between data on animals and on human beings. In the treatment of intraocular infections it would seem important to know approximately the concentration of the chemotherapeutic agent that can be obtained in the aqueous. The studies reported here were carried out in the hope of amplifying this knowledge.

Investigations have been made by Bellows and Chinn [1] on the diffusion of sulfanilamide, sulfapyridine (2-[paraaminobenzenesulfonamido]-pyridine) and sulfathiazole (2-[paraaminobenzenesulfonamido]-thiazole) in the eye in dogs and by Meyer, Bloch and Chamberlain [2] on the diffusion of sulfapyridine in rabbits. These workers have studied especially the "sulfonamide tide" in blood and ocular tissues for the twenty-four hours following a single oral dose. As they were interested only incidentally in the simultaneous blood and aqueous levels, we deemed it expedient to investigate the same drugs in an effort to obtain more information on their distribution in blood and aqueous.

From the Howe Laboratory of Ophthalmology, Massachusetts Eye and Ear Infirmary.

1. Bellows, J. G., and Chinn, H.: The Distribution of Sulfanilamide in the Eye, J. A. M. A. **112**:2023 (May 20) 1939. Chinn, H., and Bellows, J. G.: The Distribution of Sulfanilyl 1-2-Aminopyridine in the Body, J. Lab. & Clin. Med. **25**:735, 1940. Bellows, J. G., and Chinn, H.: Penetration of Sulfathiazole in the Eye, Arch. Ophth. **25**:294 (Feb.) 1941.

2. Meyer, K.; Bloch, H. S., and Chamberlain, W. P., Jr.: The Distribution of Sulfapyridine Between Blood, Aqueous Humor and Cornea, Am. J. Ophth. **24**: 60, 1941.

We have also tested the diffusion into the aqueous of a new drug, sulfadiazine (2-[paraaminobenzenesulfonamido]-pyrimidine),[3] a compound appearing to have certain distinct advantages over others in the sulfanilamide group. Feinstone and his associates [4] have found it to be absorbed readily from the gastrointestinal tract and to be excreted slowly, enabling one to maintain high blood levels with small doses. They have found it effective in the treatment of experimental infections caused by a wide variety of bacteria, including Streptococcus, Staphylococcus and Pneumococcus. It diffuses into body tissues and fluids to a degree comparable to that of sulfapyridine and in much higher concentrations than does sulfathiazole.

METHODS

With the exception of sulfanilamide, the sodium salts of the drugs were given to normal rabbits intravenously. This method was used because high blood and aqueous levels are established rapidly, administration is relatively easy and any desired blood level can be predetermined within reasonable limits. The intravenous route was not used in the work on sulfanilamide, since the sodium salt of this drug was not available. A saturated solution of sulfanilamide was administered by hypodermoclysis in doses varying from 150 to 300 cc.

In most instances samples of aqueous were withdrawn within three hours after the administration of the drug. A second paracentesis was performed from fifteen to thirty minutes after the first. Accurately measurable and sufficiently large quantities of reformed aqueous were at times difficult to obtain because of the large amount of fibrin in the anterior chamber. Samples of aqueous used for the analyses varied between 0.1 cc. and 0.35 cc., since determinations on quantities less than 0.1 cc. occasionally resulted in considerable variation between the two eyes. Samples of blood were obtained by cardiac puncture in the brief interval between the first and the second paracentesis. In a few early experiments the blood was withdrawn from a vein of the ear before the samples of aqueous were collected.

Ocular tissues other than aqueous were not studied, but a few determinations were made on the spinal fluid. Concentrations of the drug in blood and aqueous [5] were determined according to the method of Bratton and Marshall.[6]

The paracenteses were performed while the animal was anesthetized with pentobarbital sodium, intravenously administered, supplemented by 1 per cent pontocaine hydrochloride applied locally. Blank control determinations on aqueous were made for rabbits so anesthetized to rule out possible false values in the

3. This drug was synthesized by H. O. Roblin Jr., J. H. Williams, P. S. Winnek and J. P. English, as described in their article (Chemotherapy: II. Some Sulfanilamido Heterocycles, J. Am. Chem. Soc. **62**:2002, 1940).

4. Feinstone, W. H.; Williams, R. D.; Wolff, R. T.; Huntington, E., and Crossley, M. L.: The Toxicity, Absorption and Chemotherapeutic Activity of 2-Sulfanilamidopyrimidine (Sulfadiazine), Bull. Johns Hopkins Hosp. **67**:427, 1940.

5. Assistance in the chemical determinations was given by the department of chemistry of the Massachusetts General Hospital.

6. Bratton, A. C., and Marshall, E. K., Jr.: A New Coupling Component for Sulfanilamide Determination, J. Biol. Chem. **128**:537, 1939.

chemical tests for the sulfanilamide drugs. Tests were also made on in vitro solutions of known drug concentration to which various local anesthetics had been added. Pontocaine hydrochloride had no effect on the readings. In a few early experiments, ether was used as the anesthetic and the drugs were given by mouth.

RESULTS

In tables 1 to 5 the concentrations of the sulfanilamide compounds in the aqueous are recorded for each eye in milligrams per hundred cubic centimeters. The amount found in the right and that in the left eye were approximately the same in each experiment, and the average of these two values has been recorded as percentage of the blood level.

1. *Sulfanilamide.*—By averaging the results of all the experiments with this drug, we found that the average concentration in the primary aqueous was 67 per cent [7] of that in the blood and that the concentration

TABLE 1.—*The Blood-Aqueous Distribution of Sulfanilamide*

		Concentration in Primary Aqueous			Concentration in Secondary Aqueous		
Experiment No.	Blood Level, Mg. per 100 Cc.	Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level	Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level
1	33.0	22.7	21.4	61	26.8	29.5	86
2	36.0	20.6	27.4	67	....	....	....
3	20.0	16.3	19.0	86	20.0	19.9	100
4	9.4	6.4	6.9	71	11.8	9.5	114
5	14.2	11.0	13.1	85	14.1	16.7	108
6	36.4	17.0	17.5	48	26.8	28.0	75

in the secondary aqueous was 96 per cent.[7] The reformed aqueous, therefore, contained an average of 29 per cent more sulfanilamide than the primary aqueous.

Bellows and Chinn,[1] working on dogs, found in the primary aqueous a sulfanilamide concentration of 61 per cent of the blood level four hours after a single oral dose.

2. *Sulfapyridine.*—The data on sulfapyridine indicate that the primary aqueous contained 64 per cent [8] of the amount of drug in the blood. The secondary aqueous contained an average of 98 per cent [9]; this represents a 34 per cent increase. Meyer, Bloch and Chamberlain,[2] working on rabbits, found an average sulfapyridine concentration in the primary aqueous of 68 per cent of the blood level.

Sulfathiazole.—The average concentration of sulfathiazole in the primary aqueous expressed as percentage of that in the blood was 17

7. With a standard deviation from the mean of ± 11 per cent.
8. With a standard deviation from the mean of ± 13 per cent.
9. With a standard deviation from the mean of ± 19 per cent.

per cent.[10] The secondary aqueous contained 41 per cent [11] of the blood concentration; this represents an average increase of 24 per cent following paracentesis. A third paracentesis performed in 1 experiment showed no significant further change. It is evident that sulfathiazole passes the blood-aqueous barrier far less readily than sulfanilamide and sulfapyridine.

4. *Sulfadiazine.*—The primary aqueous contained an average sulfadiazine concentration of 55 per cent [12] of that in the blood and the

TABLE 2.—*The Blood-Aqueous Distribution of Sulfapyridine*

Experiment No.	Blood Level, Mg. per 100 Cc.	Concentration in Primary Aqueous: Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level	Concentration in Secondary Aqueous: Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level
7	14.3	9.6	8.2	62	17.5	14.3	111
8	10.0	10.0	10.3	102	13.3	13.6	134
9	15.4	10.2	12.0	72	16.1	16.5	105
10	13.3	10.0	11.0	79	10.5	14.6	93
11	10.0	3.4	4.0	37	6.9	7.7	73
12	20.0	10.4	11.0	54	15.4	14.5	75

TABLE 3.—*The Blood-Aqueous Distribution of Sulfathiazole* *

Experiment No.	Blood Level, Mg. per 100 Cc.	Concentration in Primary Aqueous: Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level	Concentration in Secondary Aqueous: Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level
13	5.8	1.0	0.9	18	1.9	2.0	34
14	13.7	1.9	1.6	13	4.0	5.0	33
15	8.4	3.1	2.7	34	4.7	5.1	58
16	16.1	...	1.2	8	...	3.8	24
17 †	2.0	SPT	SPT	?	...	T	?
18	23.5	1.8	2.1	8	...	...	..
19	4.1	1.4	1.7	36	2.1	...	51
20 ‡	23.0	3.8	3.2	15	...	10.7	47

* SPT, slightest possible trace; T, trace.
† Spinal fluid showed slightest possible trace.
‡ Tertiary aqueous: 9.8 mg.

secondary aqueous an average of 102 per cent.[13] Paracentesis resulted in an increase of 47 per cent in the secondary aqueous. The tertiary aqueous in 2 cases showed no significant variation from the secondary.

Postmortem Studies on Human Beings.—Blood, aqueous and spinal fluid were obtained at autopsy from 2 patients who had been given

10. With a standard deviation from the mean of ± 9 per cent.
11. With a standard deviation from the mean of ± 11 per cent.
12. With a standard deviation from the mean of ± 10 per cent.
13. With a standard deviation from the mean of ± 16 per cent.

sulfapyridine to the time of death. Blood and aqueous were similarly obtained from 2 patients treated with sulfathiazole. In all cases the eyes had presumably been normal. The blood-aqueous distribution of these

TABLE 4.—*The Blood-Aqueous Distribution of Sulfadiazine*

		Concentration in Primary Aqueous			Concentration in Secondary Aqueous		
Experiment No.	Blood Level, Mg. per 100 Cc.	Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level	Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level
21	13.8	9.2	10.0	69	10.2	11.4	74
22	16.0	9.7	9.9	61	....	14.8	92
23	20.0 *	7.1	6.8	34	27.0	25.7	130
24	12.4 †	8.1	5.7	64	....	13.2	106
25	15.2	8.6	8.3	56	....	....	...
26	14.3	6.2	6.3	44	15.8	....	110

* Tertiary aqueous: 18.8 mg., with blood level at 18.2 mg.
† Tertiary aqueous: 13.5 mg., with blood level at 7.7 mg.

TABLE 5.—*The Results of Four Postmortem Studies on Human Beings*

		Concentration in Aqueous			Concentration in Spinal Fluid	
Drug	Blood Level, Mg. per 100 Cc.	Right Eye, Mg. per 100 Cc.	Left Eye, Mg. per 100 Cc.	Average Concentration as Percentage of Blood Level	Mg. per 100 Cc.	As Percentage of Blood Level
Sulfapyridine.....	1.4	...	0.8	57	1.0	71
Sulfapyridine.....	11.6	4.9	5.3	46	8.3	72
Sulfathiazole.....	4.5	0.8	0.8	18		
Sulfathiazole.....	11.6	2.9	3.0	25		

TABLE 6.—*The Blood-Aqueous Distribution Compared with the Blood-Spinal Fluid Distribution as Studied by Other Investigators; the Values Represent Percentage of Blood Concentration*

	Rabbit Primary Aqueous	Rabbit Secondary Aqueous	Human Postmortem Aqueous	Human Spinal Fluid
Sulfanilamide.....	67	96	..	75 *
Sulfapyridine.....	64	98	51	66
Sulfathiazole.....	17	41	22	33
Sulfadiazine.....	55	102	..	50 †

* These determinations were reported by Strauss and associates.[14]
† This determination was reported by Peterson and associates.[15]

two drugs was approximately the same as in the rabbit experiments described. The determinations on sulfapyridine in the spinal fluid showed that somewhat more drug diffused into this fluid than into the aqueous.

COMMENT

The results indicate that the concentration of sulfanilamide and that of sulfapyridine in the normal rabbit aqueous are about two-thirds the blood level. The concentration of sulfathiazole in the aqueous is only about one-fifth that in the blood, while the concentration of sulfadiazine is one-half that in the blood. As can be seen in table 6, the sulfanilamide compounds diffused into rabbit and into human aqueous in approximately the proportions found by other investigators [14,15] in studying spinal fluid. It is important that the recently synthesized drug sulfadiazine, which has certain therapeutic advantages over other sulfanilamide compounds, diffuses into the eye in fairly large concentrations.

SUMMARY

The advantage of paracentesis in raising the level of the drug in the aqueous was demonstrated for the normal rabbit eye.

Four human beings were studied post mortem, and a good correlation with the results of animal experiments was found.

NOTE.—After this article was submitted, a paper by Scheie and Souders presenting similar data appeared in the ARCHIVES.[16]

Dr. David G. Cogan and Dr. Everett Kinsey helped in the preparation of this paper.

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14. Strauss, E.; Lowell, F. C.; Taylor, F. H. L., and Finland, M.: Action of Sulfanilamide, Sulfapyridine, Sulfathiazole and Sulfamethylthiazole, Ann. Int. Med. **19**:1360, 1941.

15. Peterson, O. L.; Strauss, E.; Taylor, F. H., and Finland, M.: Absorption, Excretion and Distribution of Sulfadiazine, Am. J. M. Sc. **201**:357, 1941.

16. Scheie, H. G., and Souders, B. F.: Penetration of Sulfanilamide and Its Derivatives into Aqueous Humor of Eye, Arch. Ophth. **25**:1025 (June) 1941.

SPECIFIC NERVE SHEATH TUMOR OF ORBIT (NEURILEMMOMA, NEURINOMA)

REPORT OF A CASE WITH REVIEW OF LITERATURE

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The purpose of this paper is to report a case of orbital neurilemmoma and to present a review of the literature.

The growth in question is of nerve sheath origin, solitary and encapsulated with a specific histologic appearance. Its precise cell origin is uncertain, which accounts for the bewildering array of names assigned to it—neuroma, glioma, neurinoma,[1] perineurial fibroblastoma,[2] neurofibroma, schwannoma,[3] palisaded neurinoma [4] and lemmoma. In 1935, Stout [5] sought a compromise in the name neurilemmoma, an expression indicating its accepted nerve sheath origin and avoiding reference to the controversial specific progenitor.

Neurilemmoma has been reported as occurring in both the peripheral [6] and the central nervous system.[6] Recently De Santo [7] encountered the growth in bone.

From the Departments of Pathology and Ophthalmology, St. Vincent's Hospital.

1. Verocay, J.: Zur Kenntnis der Neurofibrom, Beitr. z. path. Anat. u. z. allg. Path. **48**:1, 1910.

2. Mallory, F. B.: The Type Cell of the So-Called Dural Endothelioma, J. M. Research **41**:349, 1920. Penfield, W.: The Encapsulated Tumors of the Central Nervous System, Surg., Gynec. & Obst. **45**:178, 1927.

3. Masson, P.: Experimental and Spontaneous Schwannomas, Am. J. Path. **8**:389, 1932.

4. Geschickter, C. F.: Tumors of the Peripheral Nerves, Am. J. Cancer **25**: 377, 1935.

5. Stout, A. P.: The Peripheral Manifestations of the Specific Nerve Sheath Tumor (Neurilemoma), Am. J. Cancer **24**:751, 1935.

6. Cushing, H.: Tumors of the Nervous Acusticus, Philadelphia, W. B. Saunders Company, 1917. Bailey, P.: Intracranial Tumors, Springfield, Ill., Charles C. Thomas, Publisher, 1933, p. 70. Elsberg, C.: Tumors of the Spinal Cord, New York, Paul B. Hoeber, 1925, p. 310.

7. De Santo, D., and Burgess, E.: Primary and Secondary Neurilemmoma of Bone, Surg., Gynec. & Obst. **71**:454, 1940. Stout.[5]

We have reviewed all references [8] in the literature to tumor of the orbital nerve and were able to find only 11 cases in which the growth was described sufficiently to be classified as neurilemmoma.[9] The report of Kovács [10] was not included because the growth involved the intracranial portion of the oculomotor nerve. Another case, in which the growth was diagnosed as "Schwann cell tumor,"[11] was omitted because a histologic description was lacking, and still another, reported as a case of neuroma, was difficult to classify.[12] It was also decided to exclude instances of neurofibroma [13] and the recorded cases of plexiform neurofibroma. We feel, as have others,[14] that the latter tumor is related to Recklinghausen's disease.

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8. The report of V. Pertzeva (Neurinoma of the Orbit, Moscow, 1926, p. 257) was not available to us.

9. (*a*) Cohen, M.: Report of a Case of Orbital Neurinoma, Arch. Ophth. **54**: 426, 1925. (*b*) Reverdin, A., and Grumbach: Un cas de neurinome du nerf optique, Ann. d'anat. path. **2**:229, 1925. (*c*) Cornil and Jeandelize: Gliome périphérique des parties molles de l'orbite, Ann. d'ocul. **163**:216, 1926. (*d*) Seghieri, M.: Neurinoma dell'orbita, Boll. d'ocul. **7**:1177, 1928. (*e*) Pescatori, F.: Neurinoma solitari, Tumori **15**:59, 1929. (*f*) Papolczy, F.: Ueber ein aus einem hinteren Ciliarnerven entspringendes intra-retrobulbäres Neurinom, Arch. f. Ophth. **128**:324, 1932. (*g*) Focosi, M.: Osservazioni su di un neurinoma dell'orbita, Boll. d'ocul. **12**:1063, 1933. (*h*) Damel, C. S.; Rodríguez and Villegas, R.: Neurinoma de la orbita, Arch. de oftal. hispano-am. **35**:1, 1935. (*i*) Sitchevska, O.: Neurinoma of the Orbit, Arch. Ophth. **14**:71 (July) 1935. (*j*) Motto, P. M.: Neurofibroma of the Orbit: Report of Case, Arch. Ophth. **17**:340 (Feb.) 1937. (*k*) Friedenwald, J. S.: The Pathology of the Eye, New York, The Macmillan Company, 1929, p. 306.

10. Kovács, W.: Ueber ein solitäres Neurom des Nervus oculo-motorius, Centralbl. f. allg. Path. u. path. Anat. **40**:518, 1927.

11. Landolt, R.; Leroux, J., and Mawas, L.: Contribution à l'étude des gliomes des nerfs périphériques: Un cas de gliome du nerf sous-orbitaire, Ann. d'ocul. **162**:209, 1925.

12. Marchetti, O.: Falso neuroma del nervo sotto-orbitario, Ann. di ottal. e clin. ocul. **33**:29, 1904.

13. Tertsch, R.: Ein Neurom der Orbita, Arch. f. Ophth. **55**:121, 1902. Parker, W.: Neurofibroma of the Orbit, J. A. M. A. **49**:17 (July 6) 1907. Valude, E. M.: Neurofibrome de l'orbite développé aux dépens du nerf frontal, Ann. d'ocul. **141**: 440, 1909. Lawson, A., and Neame, H.: A Case of Neuroma of the Orbit, Tr. Ophth. Soc. U. Kingdom **41**:335, 1921. Stieren, E.: Neurofibroma of the Orbit, Am. J. Ophth. **6**:176, 1923. Accardi, V.: Neurofibroma dell'orbita, Boll. d'ocul. **6**:111, 1927. MacMillan, J. A., and Cone, W. V.: Solitary Neurofibroma of the Orbit, Arch. Ophth. **10**:51 (July) 1933. von Heuss: Retrobulbärer neurogen Tumor neurofibromartiger Struktur, Klin. Monatsbl. f. Augenh. **88**:240, 1932. Kreibig, W.: Zur Kenntnis seltener Orbitaltumoren, Ztschr. f. Augenh. **95**:113, 1938.

14. Davis, F. A.: Plexiform Neurofibromatosis (Recklinghausen's Disease) of Orbit and Globe, Arch. Ophth. **22**:761 (Nov.) 1939. Foot, N. C.: Histology of Tumors of the Peripheral Nerves, Arch. Path. **30**:772 (Sept.) 1940.

Summary of Data

Authors	Years of Publication	Age of Patient	Sex	Symptoms and Findings								Treatment			Gross Pathologic Appearance						
									Fundus												
				Orbit Involved	Proptosis	Impaired Motility of Eye	Vision Diminished	Pain	Edema of Disk	Atrophy of Disk	Congestion	Radiation	Removal of Tumor	Complete Exenteration	Location of Tumor in Orbit	Shape	Size	Encapsulation	Color	Solid or Cystic	Degeneration
Cohen.....	1925	11	M	Right	2 yrs.	Yes	—	—	Yes	—	Yes	—	Yes	—	Superior	Oval	3.5×2.2 cm.	Yes	Gray	Solid	Yes
Reverdin and Grumbach	1925	70	F	Right	11 yrs.	Yes	Yes	—	—	—	—	—	Yes	—	Superior	—	5×4×2.5 cm.	Yes	Gray	Solid	Yes
Cornil and Jeandelize	1926	11	M	No data	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Seghieri.....	1928	18	F	Left	8 yrs.	Yes	Yes	Yes	—	—	—	Radium	Yes	—	Inferior	Oval	2.5×1.5 cm.	Yes	Gray	Solid	Yes
Pescatori, case 4	1929	18	M	Left	16 yrs.	—	Yes	—	—	—	—	Radium	Yes	—	Inferior	—	—	—	—	—	—
Papolczy.....	1932	43	M	Left	—	Left eye atrophied since birth						—	—	Yes	Inferior	Oval	Walnut	Yes	Gray	Cystic	Yes
Focosi.....	1933	42	F	Left	2½ yrs.	—	—	Yes	Yes	Yes	—	—	—	Yes	Filled whole orbit	Pyramidal	9 × 4 cm.	Yes	Gray	Solid	—
Damel and others	1935	36	M	Left	3 yrs.	—	—	—	Yes	—	—	—	Yes	—	Superior	Oval	3.5×2 cm.	Yes	Gray	Cystic	Yes
Sitchevska.....	1935	28	F	Right	2 yrs.	Yes	Yes	—	Yes	—	Yes	X-Ray	Yes	—	Lateral	Oval	2.9×2 cm.	Yes	Gray	Solid	Yes
Motto.....	1937	37	M	Left	2 yrs.	—	Yes	—	—	Yes	—	X-Ray	Yes	—	Inferior	—	—	—	—	—	—
Friedenwald...	1929	—	—	—	—	—	—	—	—	—	—	—	—	—	Optic nerve	—	—	—	—	—	—

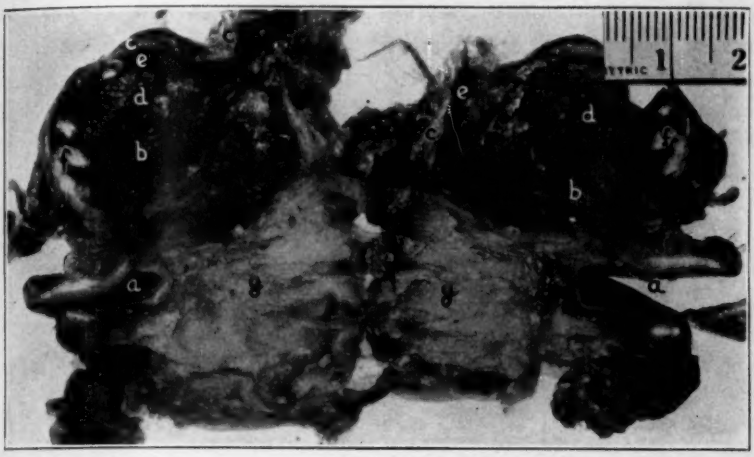

Fig. 1.—Gross specimen. Note (*a*) eyeless socket, (*b*) tumor, (*c*) fibrous capsule, (*d*) bulk of tumor replaced by blood clot, (*e*) cystic portion, (*f*) peripheral yellow portion and (*g*) orbital fat.

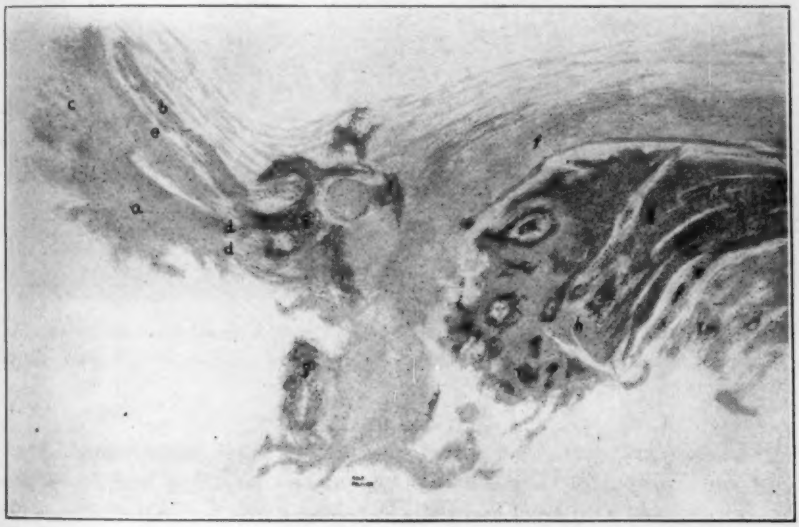

Fig. 2.—Drawing of a low power view of the main tumor and the neurofibromatous nodule. Note (*a*) the neurofibromatous nodule; (*b*) the nerve coursing in its capsule; (*c*) the nerve entering the nodule; (*d*) nerves leaving it; (*e*) perineurial connective tissue; (*f*) connective tissue about the main tumor; (*g*) hemorrhage, and (*h*) neurilemmoma tissue.

Intraorbital neurilemmoma occurred in either orbit of persons of both sexes from 2 to 70 years of age (see table). The tumor grew progressively or intermittently, with stationary periods of varying lengths. Thus, in 1 case [9e] the neoplasm was first evident at the age of 2 years but remained quiescent for fifteen years before further growth became manifest. The rate of growth, though usually slow, might during any one period become rapid. The average interval between the appearance of symptoms and therapeutic intervention was about three years.

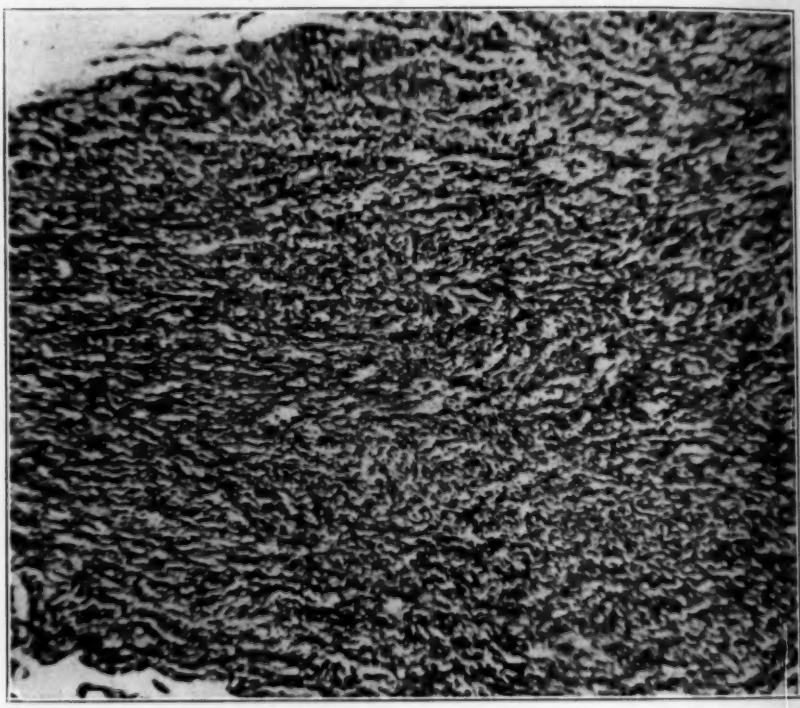

Fig. 3.—Low power photomicrograph (Foot and Foot reticulum stain) of a section through a small nodule outside the main tumor. Note the large quantity of reticulum present.

Clinical data were available in 9 cases. In these the cardinal symptoms were proptosis, diminution of vision and impaired motility of the eye. Occasionally diplopia and pain were noted. The tumor could always be palpated through the lids. The fundi invariably showed some change; congestion, edema and atrophy of the disk were noted.

In 2 cases [9d,e] radium therapy and in 2 others [9i,j] roentgen therapy was attempted, without success. The treatment therefore resolved itself into removal of the growth in 8 cases. In these proptosis was corrected.

vision improved somewhat and normal motility restored. In regard to the remaining cases, in 2 [9f,g] the eyes were useless, so that complete exenteration was the operation of choice, and in 1 [9k] no data were available.

In 2 cases [9a,b] reported two years after operation there had been no recurrence.

The tumor in every instance was solitary and encapsulated. It was oval or pyramidal and varied in size from 2.5 by 1.5 to 9 by 4 cm. In

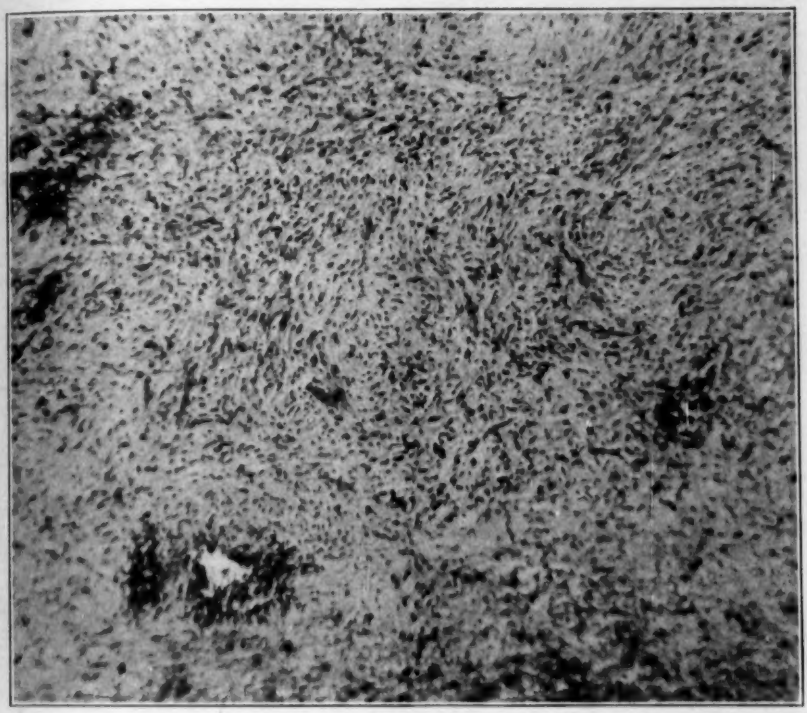

Fig. 4.—Low power view (hematoxylin and eosin stain) of an area within a neurofibromatous nodule. Note the cellularity, the oval nuclei and the whorled arrangement.

addition, it felt firm or elastic and was composed of gray solid tissue with yellow areas. In some cases it exhibited hemorrhage and cystic change.

The nerve of origin could not be determined except in the case reported by Friedenwald,[9k] who offered a photograph depicting the tumor within an optic nerve. Visual evidence of the neoplasm adherent to the same nerve in the case of Reverdin and Grumbach [9b] can scarcely be accepted as proof of origin here. In regard to location of the tumor

within the orbit, 4 were observed superior, 3 inferior and 1 lateral to the optic nerve. One filled the entire socket, and the location of the last was not specified.

REPORT OF CASE

M. L., a 59 year old woman, entered St. Vincent's Hospital Nov. 9, 1939, complaining of a swollen lid and inability to retain an artificial eye.

The history went back to 1917, when, during an explosion (in Nova Scotia), flying debris struck the patient in the left eye. Three months later she noticed diminution of vision in this eye. In September 1919 she was seen by a physician,

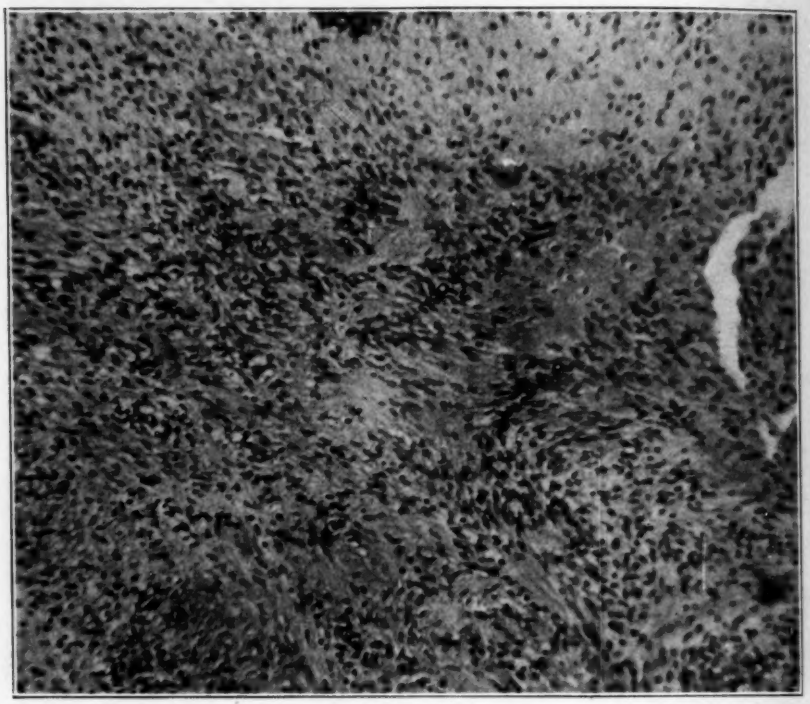

Fig. 5.—Low power photomicrograph (hematoxylin and eosin stain) of typical Antoni type A tissue. Note the palisading of the cells (*a*).

who noted unilateral proptosis and removed the organ. In the orbit a cystic mass was found, which unfortunately was not studied.

She was fitted with an artificial eye and remained well until 1935, when the glass eye began to slip out and the upper lid swelled.

The only abnormality disclosed by physical examination was a mass measuring 3 by 2 cm. within the left upper eyelid, pushing it forward and down. The mass extended back beneath the superior orbital ridge into the orbit. It felt smooth and cystic and appeared freely movable. The socket (fig. 1) was shrunken, and its roof was depressed by the tumor. On insertion of a needle through the roof of the socket into the tumor, 5 cc. of clear fluid was withdrawn. This

procedure was followed in four days by an incision through the same site, insertion of a curet and removal of a small amount of tissue, which proved to be a neurilemmoma.

On November 28 a complete exenteration of the left orbit was performed. During the operation, the bony roof of the orbit was found defective and the dura was exposed. Rapid recovery ensued. When seen again, in thirteen months, the patient was well, no recurrences having taken place.

Pathologic Report.—The specimen was a mass measuring 5 by 4.5 cm. and weighing 50 Gm. (fig. 1). It consisted of the superior and inferior tarsus with

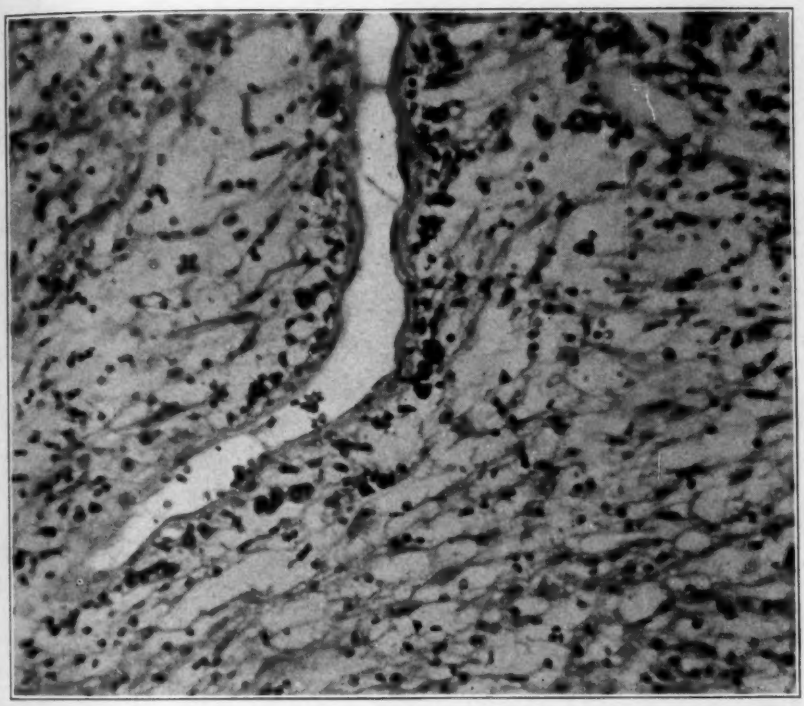

Fig. 6.—High power photomicrograph (hematoxylin and eosin stain) of a section through the yellow portion of the tumor, showing large polyhedral lipoid-filled macrophages.

eyelash-covered palpebral margins bounding a small, shrunken, eyeless socket. Intimately fixed to the upper posterior surface of the superior tarsus was a spherical mass 3 by 3.5 cm., composed of an outer, dense fibrous capsule enclosing a soft, brittle, hemorrhagic gray mass the center of which was cystic and filled with clotted blood. At the periphery were small areas which were distinctly yellow. Externally, fine threadlike nerves were observed coursing on the outer surface of the capsule. Below the tumor (but not connected to it in any way) and buried in the orbital fat was found the atrophied stump of the optic nerve.

Microscopic Examination.—After fixation in a 10 per cent concentration of solution of formaldehyde U. S. P. one half of the specimen was cut into small

blocks and prepared in paraffin. Several sections were cut from some of these. The following stains were found useful: hematoxylin and eosin, a modification of Masson's trichrome stain,[15] the Foot and Foot reticulum stain,[16] sudan III[17] for fat and the prussian blue[17] stain for iron.

The capsule of the tumor was densely fibrous. Immediately outside it were many thickened, tortuous nerves, which pierced it and became lost within it. In each nerve there appeared to be an increase in the amount of endoneurial and perineurial connective tissue. Among the nerves several small nodules were observed, the largest measuring roughly 1.5 by 1 mm. (fig. 2). Thickened nerves also entered these nodules or coursed through their capsules. The nodules were

Fig. 7.—High power photomicrograph of Antoni type B tissue. Hematoxylin and eosin stain. The cells have lost their elongated appearance and are arranged in a reticular pattern.

composed largely of reticulin (fig. 3) and cells with elongated nuclei arranged in intertwining bands and whorls (fig. 4). In some areas their numbers were so

15. Larson, C. P., and Levin, E. J.: A Modification of Masson's Tetrachrome Stain, Arch. Path. **29**:272 (Feb.) 1940.

16. Foot, N. C., and Foot, E. B.: A Technique of Silver Impregnation for General Laboratory Purposes, Am. J. Path. **8**:245, 1932.

17. Mallory, F. B., and Wright, J. H.: Pathological Technique, ed. 7, Philadelphia, W. B. Saunders Company, 1921.

scant that the nodules appeared like fibromas. Axis-cylinders were observed at the periphery of one nodule.

The large tumor was richly cellular. In many areas the cells were elongated, contained oval nuclei, were closely packed and were arranged in interlacing bands and whorls. Typical palisading of the nuclei was observed (fig. 5). Considerable portions of the tumor presented a looser appearance. Here the cells were small, irregular and arranged in reticular fashion (fig. 6). Large numbers of macrophages filled with lipoid material were present throughout, most strikingly at the periphery (fig. 7).

The tumor was rich in fine delicate reticulin fibers pursuing a longitudinal course in areas where the cells were observed in bundles and palisaded where the nuclei were similarly arranged. Blood vessels were numerous, of wide caliber and as a rule thin walled. Some, however, were much thickened and thrombosed.

Many cells filled with iron pigment were noted, chiefly about the blood vessels. Also present were areas containing lymphocytes.

The central portion of the growth was cystic and filled largely with clotted blood.

COMMENT

The tumor in the case presented here was a typical neurilemmoma, since portions of it were composed of Antoni A (fig. 5) tissue, while other areas exhibited the marked regressive changes so characteristic of this tumor, namely, type B tissue (fig. 6) infiltration with lipoid-ingesting macrophages, cysts and thick-walled blood vessels.

The question of latent *"Rankenneurom,"* raised by the presence of thickened nerves, neurofibromatous nodules outside the capsule of the main tumor and a perforated orbital roof was dismissed because *"Rankenneurom"* is characterized by a train of symptoms which relate it to Recklinghausen's disease.[18] These become manifest at birth or soon after with varying degrees of buphthalmos, absence of one or more orbital bones, elephantiasis of the lid, cheek and temporal region, hemihypertrophy of the tongue and café au lait pigmentation of the skin. In our case the disease appeared late in life and, further, none of the aforementioned stigmas was present except perforation of the orbital roof, accounted for by pressure atrophy. In other reported cases, however, 1 patient had pigmented spots about the body, and another, four elastic cutaneous nodules suspected to be neurofibromas.

We called the extracapsular nodules neurofibromas principally because they contained a considerable amount of connective tissue. How-

18. Billroth, T.: Plexiformes Neurofibrom des oberen Augenlides und der Schlafengegend, Arch. f. klin. Chir. **11**:232, 1869. Sachsalber, A.: Ueber das Rankenneurom der Orbita mit sekundärem Buphthalmus, Beitr. z. Augenh. **27**:1, 1898. Marchand, R.: Das plexiforme Neurom, Virchows Arch. f. path. Anat. **70**:36, 1877. Rockliffe, W. C., and Parsons, J. H.: Plexiform Neuroma of the Orbit, Tr. Path. Soc. London **55**:27, 1904. Kiel, E.: Ueber ein Rankenneurom der Orbita, Arch. f. Ophth. **112**:187, 1923.

ever, it must be admitted that the presence of elongated cells arranged in whorls might support a diagnosis of sclerotic neurilemmoma, especially since Masson described sclerosis as one form of degeneration to which the tumor is heir.

Our case differs from those previously reported in that the tumor arose in an eyeless orbit from which a growth had been removed twenty years before. The relation between the two is interesting to contemplate but impossible to explain, because no study of the first neoplasm was made other than to note that it was cystic. Stout, who reviewed all reported instances of neurilemmoma outside of the cranial vault, recorded only 1 authentic case of recurrence.[19]

SUMMARY AND CONCLUSIONS

A report of a case of neurilemmoma occurring in the orbit is presented, together with a review of the literature.

The tumor is solitary; it originates in a nerve sheath and may appear in either the central or the peripheral nervous system. Eleven cases of orbital neurilemmoma are reviewed.

The neoplasm grows usually at a slow rate, progressively or intermittently, with varying static intervals. The largest tumor reported measured 9 by 4 cm.

The tumor is essentially solid and gray and has a specific histologic appearance.

It is prone to degenerative changes which modify its gross and histologic appearance.

The symptoms produced are due to its expanding growth which pushes, crowds and compresses the normal orbital structures.

The tumor is benign.

It is to be differentiated from solitary neurofibroma and plexiform neurofibroma *(Rankenneurom)*, which also occur in the orbit.

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19. Stout, A. P.: The Malignant Tumors of the Peripheral Nerves, Am. J. Cancer **25**:1, 1935.

RETINAL HEMORRHAGE FOLLOWING TRANSFUSION

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The problem of retinal hemorrhage following transfusion is not new, but the question does not seem to be completely clarified by the previous reports in the literature. The most recent study has been published by Gray,[1] and in this report he has reviewed the literature and submitted additional information through a report of 85 cases in which 2 patients had retinal hemorrhage after a transfusion. Apparently Sallmann [2] was the first to report the occurrence of retinal hemorrhage after transfusion; he observed 3 cases. He was followed by Schaly,[3] who reported 4 cases. The first study of the question was made by Messinger and Eckstein,[4] who observed 60 cases before and after transfusion and found new retinal hemorrhages in 10, or 16 per cent. Titov and Bogomolova [5] reported on 7 patients with retinal hemorrhage in a series of 100 studied (7 per cent). Gray found 2 patients with retinal hemorrhage in a series of 85 (2.6 per cent).

A series of 100 transfusions given to 88 patients is reported here. Examination of the fundi was made prior to the transfusion and within forty-eight hours after administration of from 250 to 600 cc. of citrated fresh blood. In 64 of the transfusions 500 cc. or more of blood was given. In 26 the amount given was between 250 and 350 cc. Hemorrhages were found in the fundi of 8 patients at the first examination, and in only 1 of these were fresh hemorrhages observed at the time of the second examination. Febrile reactions, with a temperature ranging

From the Department of Ophthalmology, College of Medicine, State University of Iowa.

1. Gray, R. J.: Retinal Hemorrhages After Transfusion, Am. J. Ophth. **22**:979, 1939.

2. Sallmann, L.: Ueber Makulablutungen nach Bluttransfusion bei perniziöscher Anämie, Wien. med. Wchnschr. **25**:2554, 1925.

3. Schaly, G. H.: Netzhautblutungen nach Bluttransfusion, Klin. Monatsbl. f. Augenh. **77**:350, 1926.

4. Messinger, H. C., and Eckstein, A. W.: Retinal Hemorrhages After Transfusion, Rhode Island M. J. **14**:171, 1931.

5. Titov, I. G., and Bogomolova, L. G.: Retinal Hemorrhages During Transfusion, Vestnik oftal. **12**:109, 1938.

from 102 to 105 F. following a chill, occurred in 9 patients, but in none of the patients was there any evidence of a major transfusion reaction. None of the patients who had chills and fever showed retinal hemorrhage. In all cases the patients and the donors had blood of the same type, and cross agglutination tests were performed before the administration of blood. The transfusions were given in the treatment of anemia and shock and for supportive purposes.

Fresh retinal hemorrhage was observed in 3 cases after transfusion. In these diagnoses were (1) appendical abscess, (2) diabetes mellitus and (3) myelogenous leukemia. In each case only a single small flame-shaped or punctate hemorrhage was found in one or both eyes. A short report of these cases follows.

REPORT OF CASES

CASE 1.—A white man 26 years of age was admitted to the hospital with a diagnosis of ruptured appendix and localizing peritonitis. The temperature was 102.2 F. The red blood cells numbered 4,600,000 and the white blood cells 29,600 per cubic millimeter; the value for hemoglobin was 90 per cent. The patient was very toxic, but blood cultures were sterile. Treatment consisted of drainage of the appendical abscess. The patient's blood was of type IV. He received 300 cc. of type IV blood after cross matching. No reaction followed the administration of the blood. Thirty-six hours after the transfusion a very small striate hemorrhage was observed somewhat inferior to the disk of the left eye.

CASE 2.—A white man 21 years of age was admitted to the hospital because of diabetic acidosis and coma. General examination revealed no abnormality except an unexplained fever (temperature 101 to 103 F.). The red blood cells numbered 3,300,000 per cubic millimeter; the value for hemoglobin was 11 Gm.; the white blood cell count was 6,600 per cubic millimeter, and the differential count was normal. On admission the urine showed a trace of albumin and gave a 4 plus reaction for sugar. The blood sugar content was 404 mg. per hundred cubic centimeters. Prior to the transfusion a small flame-shaped hemorrhage was observed in each eye. Twenty-four hours after the transfusion a new small striate hemorrhage was seen below and nasal to the disk in the left eye.

CASE 3.—A white girl 5 years of age was admitted to the hospital because of chronic myelogenous leukemia. On admission the value for hemoglobin was 64 per cent; there were 2,660,000 red cells and 22,250 white cells per cubic millimeter of blood. Many myelocytes and nucleated red cells were seen in the smear. The blood was of type II. The temperature varied between 99 and 101 F. The fundi were normal, but after a transfusion of 250 cc. of compatible citrated blood a small flame-shaped hemorrhage was observed above the macula in the right eye. In the left eye a small punctate hemorrhage was seen in the macula and in the nerve head. After a second transfusion, eight days later, there were no new hemorrhages. There was no general reaction to either transfusion.

COMMENT

In the various reported series of observations of the ocular fundi after transfusion a great difference exists in the percentage of cases of

retinal hemorrhage. Messinger and Eckstein reported 16 per cent; Titov and Bogomolova, 7 per cent, and Gray, 2.6 per cent, and our series shows 3.4 per cent. The discrepancy between these figures is obvious, and it is not reasonable that such a great variation would occur in four series if a single factor (transfusion) were responsible. If the number of transfusions given is considered, one finds that the difference is still noteworthy, for Messinger and Eckstein reported 73 transfusions, after 13.7 per cent of which retinal hemorrhage developed; Gray reported 343 transfusions, after 0.8 per cent of which hemorrhage occurred, and in our series of 100 transfusions 3 per cent were followed by hemorrhage.

It seems reasonable to assume that several factors influence the appearance of retinal hemorrhage following blood transfusion. One cannot consider the administration of blood alone, for the influence of the general condition from which the patient suffers must be evaluated, particularly if a tendency toward retinal hemorrhage is produced independently by the primary disease. In this respect leukemia is a good example, since retinal hemorrhage commonly is found in the patient who does not have a transfusion, and a new hemorrhage may develop from time to time without any new recognizable etiologic factor. Such a patient may go on for days without any retinal involvement; then suddenly retinal hemorrhage appears without any change in the general condition. A similar state exists in diabetes, arteriosclerosis, hypertension, nephritis, septicemia, pernicious anemia, aplastic anemia and purpura haemorrhagica. When a transfusion is given to a person with any of these diseases it appears logical to consider whether the patient is liable to hemorrhage because of his general condition before attributing the cause to the transfusion itself.

Although hemorrhage was observed in 8 of our patients before transfusion, in only 1 of these was fresh hemorrhage observed at the second examination. Since this patient was diabetic, it might be assumed that the new hemorrhage was a spontaneous one, not related to the transfusion; yet proof of this is not possible. In Titov and Bogomolova's series, 6 of the 7 patients in whom hemorrhage was found had hemorrhage before transfusion. On the other hand, the Messinger and Eckstein series contained only 1 case of hemorrhage at the first examination, but there were 5 cases in the series in which the diagnoses were compatible with the occurrence of spontaneous retinal hemorrhage. Likewise, Gray noted only 1 case of hemorrhage before transfusion, but in a total of 8 cases there were diagnoses which made retinal hemorrhage predictable. Our patients included 9 in addition to the 8 previously mentioned in whom retinal hemorrhage might have been expected because of the general disease but in whom no such hemorrhage was seen at the examination before transfusion; of these, 1 had a fresh

hemorrhage after transfusion. Furthermore, 6 of the 7 patients described by Sallmann and Schaly suffered from blood dyscrasias (the primary disease of the seventh was not recorded by Sallmann). A summary of our own cases with those of Gray and those of Messinger and Eckstein shows that 1 of 4 patients with hemorrhagic disease had retinal hemorrhage after transfusion, while only 1 of 29 patients with nonhemorrhagic disease showed this phenomenon. Although it appears from this consideration that a direct relation exists between the occurrence of retinal hemorrhage after transfusion and any general disease in which retinal hemorrhage spontaneously occurs, this does not mean that the transfusion itself is the etiologic factor, for the new hemorrhage may be and perhaps is purely coincidental. This opinion is substantiated by the number of patients with retinal hemorrhage who do not have fresh hemorrhage after transfusion. That the general disease is not the only factor is demonstrated by the occurrence of hemorrhage in patients in whom there is no hemorrhagic tendency.

In our series, nine transfusions were followed by chills and fever. The temperature reaction of the patients varied, the range being 102 to 105 F. It is interesting to note that in none of these patients were hemorrhages demonstrated after the transfusion or chill, yet 1 of them had leukemia. Apparently minor reactions have nothing to do with the occurrence of retinal hemorrhage. One patient in Gray's series had a severe transfusion reaction, and the same circumstance prevailed in a single case reported by Borsotti.[6] Messinger and Eckstein stated that no general reaction occurred in any of their patients, and the Titov and Bogomolova series apparently was also unaccompanied with complications. Whether or not severe transfusion reaction plays any part is not definitely known, but it may be considered an unusual circumstance which may contribute toward the development of hemorrhage.

It is possible that the degree of the anemia itself may play a part in the production of retinal hemorrhage, but again the evidence is inconclusive. Of Messinger and Eckstein's patients there were 18 with red blood cell counts of less than 2,000,000 per cubic millimeter; of these, 6 had retinal hemorrhage after transfusion. Gray did not give details concerning the anemia in his series, but the 2 patients with retinal hemorrhage had less than 2,000,000 red blood cells per cubic millimeter. Ten of the patients in this series had erythrocyte counts under 2,000,000, yet none of these had fresh retinal hemorrhage after transfusion, although 4 had such hemorrhage before transfusion.

In analyzing the cases with these secondary factors in mind, we find that 5 (8 per cent) of the patients in the Messinger and Eckstein series

6. Borsotti, I.: Incidenti oculari in seguito a trasfusione de sangue, Boll. d'ocul. **16**:830, 1937.

had retinal hemorrhage that was perhaps due to the transfusion. In only 1 (1 per cent) of the 100 cases reported by Titov and Bogomolova was the condition uncomplicated by other factors, and in Gray's series there were no cases in which complications were not present. In our 88 cases there was 1 such case (1.1 per cent). In the total of 333 cases, there were 7 cases (2.2 per cent) in which retinal hemorrhage occurred without other apparent contributing causes.

Except in the data given by Messinger and Eckstein, the frequency of hemorrhage following transfusion is small. No apparent explanation can be given for the high percentage recorded by the aforementioned writers; yet it is obvious that their experience does not conform with subsequent reports. We feel that retinal hemorrhages are infrequently encountered after transfusion unless a general disease in which retinal hemorrhage spontaneously occurs is present. In such a disease increased bleeding following transfusion is perhaps coincidental and not due to the administration of blood. The causes of the occasional retinal hemorrhage in an occasional case of uncomplicated anemia remains unexplained, but it may be related to change in blood pressure, toxemia or a febrile state.

CONCLUSIONS

1. Retinal hemorrhage after transfusion is not common.

2. The frequency of retinal hemorrhage is much greater among patients in whom a tendency to spontaneous retinal bleeding exists, but in such patients fresh hemorrhage after transfusion is perhaps coincidental.

3. No relation exists between retinal hemorrhage after transfusion and minor reactions or between retinal hemorrhage after transfusion and the degree of anemia.

Ophthalmologic Reviews

EDITED BY DR. FRANCIS HEED ADLER

APPLIED ANATOMY OF THE EYE

ITS RELATION TO OPHTHALMIC SURGERY

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The ocular anatomy is of the highest importance in any surgical procedure about the eye. It is therefore desirable to describe the anatomic milieu as much as is needed, but it is not essential to give much detail. Descriptions of muscle origins and insertions, innervations, arterial supplies, etc., are interesting, but they can be looked up at any time. The principal anatomic landmarks which have to do with the eye from a surgical point of view will be considered.

THE LACRIMAL SYSTEM

The lacrimal gland is like a large reservoir of tears. In the vicinity of the large reservoir are smaller ones, or springs. The large reservoir is the main source of supply of the tears and is the lacrimal gland. The other, smaller springs correspond to the glands of Krause, which number from eighteen to twenty in the upper fornix and from eight to ten in the lower and which act as accessory lacrimal glands. If the supply from the main reservoir should go dry, as after extirpation of the lacrimal gland, there would still be a supply from the smaller springs.

After the tears come out of the large reservoir, they enter the palpebral fissure, spread across the cornea and wash off the dust and bacteria. They then collect in the inner corner of the eye—the lacus lacrimalis. Into this pool the two little puncta dip which drain into the canaliculi, carrying tears over to the sac and from the sac down to the nose.

The tears pass down to the nose in four ways:

1. By gravity.

2. By capillary attraction.

3. By the elasticity of the sac, so that when it is distended it tends to contract.

4. By the action of Horner's muscle drawing out the sac, creating a negative pressure and then relaxing.

The tears will rarely run back, because there is a muscle around each punctum and the upper part of the canaliculus which prevents the return flow of tears from the sac. Before doing any intraocular operation it is always well to inspect the sac to see whether it is distended with pus. In fact, before any intraocular operation it is well to wash through the lacrimal passages.

The orbit is divided into four parts. The upper outer quadrant is characterized by the location of the lacrimal gland; the upper inner quadrant, by the trochlea of the superior oblique muscle, and the lower inner quadrant, by the fossa for the lacrimal sac and the origin of the inferior oblique muscle. The lower outer quadrant has no significance. In the upper outer quadrant there is a depression under the rim of the frontal bone for lodgment of the lacrimal gland. This gland is separated into two parts—an orbital portion and a palpebral portion—by the aponeurosis of the levator palpebrae superioris muscle. Numerous ducts from this gland enter into the superior fornix of the conjunctival sac. It is well to remember that there are one or two ducts which come around below the external canthal ligament to open into the inferior conjunctival fornix. This is of interest in connection with Jameson's operation, which will be discussed later.

Two terms are used in regard to tearing. They are lacrimation and epiphora. Lacrimation is excessive secretion and flow of tears due to emotional upset, the presence of a foreign body or irritation from a room filled with smoke. The tears gather too fast in the corner of the eye (in the lacus lacrimalis) and spill over onto the cheek. When there is an obstruction of the lacrimal ducts and the tears overflow, the condition is called epiphora. The obstruction may be in the puncta, the canaliculi, the sac or the canal.

One does not often operate on the lacrimal gland except in cases of injury with abscess formation, cyst or tumor. Sometimes, when there is an injury to the gland with a resultant fistula, one may operate to eradicate the fistula. If there is an abscess or inflammation of the gland, one removes it. The principal operative procedure on the gland is done after an operation has been performed to extirpate the lacrimal sac and the patient complains of severe epiphora following it. Two procedures may be followed. The first is removal of the accessory lacrimal gland. Procaine hydrochloride is injected into the lid on the outside. The lid is inverted to the tarsal fold with an Ehrhardt clamp, and 2 per cent procaine hydrochloride is injected into the superior fornix. An incision is made about 3 mm. above the tarsal surface. The patient is directed to look down and inward to expose the accessory lacrimal gland. After dissection of the conjunctiva above and below, that portion of the lacrimal gland can be dissected out from under the upper lid. This is not always sufficient to relieve the tearing, however, and one may have to do

more. In the second procedure the orbital portion of the lacrimal gland may have to be removed. To remove the orbital portion one raises the brow above the bony orbit so that the clear part of the skin is above the orbital rim. One then makes an incision along the lower hair line of the brow down to the periosteum. It should never be carried nasalward past the limbus of the eye. A perpendicular dropped from the brow to the outer edge of the cornea gives the point from which the incision is to be made outward. The reason for this is that if one goes nasal to the limbus one may cut too much of the septum orbitale and have difficulty in reattaching it. This may give rise to annoying ptosis, which is most difficult to correct. Coming out from the back of the orbit, the aponeurosis of the levator muscle is fused with the septum orbitale, so that when the lid closes the latter goes forward and helps to support the upper lid. The septum orbitale is such a delicate tissue that it is difficult to pick up. One never goes farther nasalward, then, than the external limbus of the eye. After the incision is made and spread open, one will have above, attached to the rim of the orbit, the septum orbitale. This should be cut off close to the orbital rim, the yellowish pink lobes of the lacrimal gland being exposed. The gland should be picked up with a forceps and can be shelled out of the lacrimal fossa above, where there is no connection with the orbit except for a thin layer of areolar tissue. The gland is connected with the conjunctiva and with the aponeurosis of the levator palpebrae muscle and should be dissected free below and on either side. The gland is supplied by the lacrimal branch of the ophthalmic artery, which comes in from behind. If there is much bleeding during this dissection one must pinch off the bleeders with forceps; otherwise a hematoma may result. After the gland tissue has been removed, the septum orbitale should be sutured to the orbital rim with plain catgut and the skin should then be closed with no. 1 black silk. The sutures should be placed at the edge of the skin to avoid scarring.

It is well here to mention Jameson's operation. He makes an incision in the conjunctiva at the outer canthus of the eye after the conjunctiva has been well ballooned with procaine hydrochloride. He then snips along under the surface of the conjunctiva in an attempt to cut the ducts from the lacrimal gland as they enter the conjunctival sac. When these are completely severed, the tears accumulate subconjunctivally for a time, and then the gland gradually atrophies. It is difficult, however, to catch all the ducts. There is a caruncle at the inner corner of the eye, and just outside this is the plica semilunaris—a remnant of the nictitating eyelid. The lower punctum enters between the plica semilunaris and the conjunctiva. The upper punctum dips in between the caruncle and the semilunar fold. The lower punctum is 6.5 mm. from the inner canthus, and the upper is 6 mm. distant. The puncta dip into the lacus lacrimalis. These puncta are the entrances to the canaliculi

which run nasalward to be joined and to enter the lacrimal sac. They are 10 mm. in length.

There are three landmarks that are most important in surgical treatment of the lacrimal sac. These are the anterior crest of the lacrimal groove, the posterior crest of the lacrimal groove and the internal canthal ligament.

To bring out some practical ideas of when to operate, a few examples may be given. A mother may bring a child of about 4 months to the surgeon. The child's eyes are matted together, and tears are running down the cheek. The child probably has an obstruction of the tear passages. In a newborn baby the lacrimal ducts are a column of cells. At the time of birth these cells liquefy, leaving tubes behind. In some children the cells do not liquefy early, or perhaps the cells and debris block the canaliculus, causing the lacus lacrimalis to fill with tears. If this persists for a long time subacute conjunctivitis may result. The child may be placed in a hospital and the tear passages probed at once, but this means the use of an anesthetic. It has been found that if one waits long enough, in almost every case the tearing will clear up. The mother should be instructed to keep the eye clean with warm boric acid and to use boric acid ointment to keep the lids from matting together. She should also be advised to use pressure over the inner canthus from time to time, so that the debris will be expelled from the sac. If the condition persists, however, until the child is 7 months old, one must probe the duct.

There are two kinds of punctum dilators, the dull and the sharp. The dull dilator is the same as the no. 1 Bowman probe. It is best to use the sharp punctum dilator, but in using it one must be extremely careful not to tear the tissues. After the tip of the probe has been inserted in a perpendicular direction the probe is turned nasally until one has dilated the punctum sufficiently to admit the probe. After the punctum dilator has been withdrawn one should introduce a Bowman probe perpendicularly and then turn it nasally until resistance is encountered against the bone of the nose. If one turns it down too soon one may tear a hole in the canaliculus and pass into the cheek. After one reaches the bone of the nose one should turn the probe down and aim for the groove between the nose and the cheek.

One may encounter a baby who has constant inflammation of the tear sac even after probing. In a great many cases, when this pus persists in a baby the cause is a tuberculous infection. Such a condition is best treated with roentgen rays, since probing will make it worse. Extirpation of the sac may not relieve the inflammation.

If a young man or woman experiences excessive tearing after taking cold, one may find that there is blocking of the lacrimal passages. The physician can do a great deal of good by undertreating rather than overtreating the patient. By syringing the sacs through one may wash

out the debris that is blocking the canal. One should put a drop of pontocaine hydrochloride over the punctum, and then inject about 1 cc. of epinephrine hydrochloride with 1 drop of 2 per cent cocaine hydrochloride into the canaliculus and the sac with a blunt lacrimal needle. The sac and the lacrimal canal are surrounded by a plexus of veins and arteries. By injecting the epinephrine one shrinks the vessels and opens the lumen. It is a good thing to pass a probe once or twice, but repeated probing is not justified. If the tearing persists the patient should be advised to have a dacryocystorhinostomy. The outlet of the lacrimal duct in the nose should be inspected, as its opening may be blocked.

In cases of acute inflammation of the sac the Weber or the Agnew canaliculus knife may be used. The knife is passed into the punctum until the blunt olive-shaped tip touches the bone of the nose, and if one lifts up on the knife the sharp edge will cut through the canaliculus. A large probe is then passed down through the canal into the nose (Agnew operation). One can also cut from the outside, but one is more apt to cause scarring and a fistula by this procedure.

Sometimes the canaliculus in an old person is slit to promote the flow of tears, but it is much better to cauterize the inner side of the punctum, where the punctum is everted. The resulting scar tissue will draw the punctum up into the proper position. One may slit the canaliculus in cases of scarring or when the punctum has been destroyed.

Whenever any solution is injected into the sac, one should use boric acid solution, saline solution or a watery solution, because one never knows whether in operating in the tear sac a false opening has been made. Mild protein silver or any other colored fluid may stain the cheek.

If there is a nonpurulent sac (mucocele) which after being probed once or twice closes up again, it is best to do a dacryocystorhinostomy. In the presence of a chronic sac with pus, one is not justified in breaking the bone to form an opening into the nose, because of the danger of osteomyelitis.

By pulling the lids over to the temporal side one can almost always see the internal canthal ligament. Procaine hydrochloride should be injected into the skin over the surface of the sac. The anterior lacrimal nerve and the infraorbital nerve should also be anesthetized. To start an incision for an operation on the sac one should begin at a point 3 mm. nasalward and 3 mm. up from the inner canthal angle and then cut down in a curved line a little below the skin of the lower lid onto the cheek bone. One should not hesitate to make the incision long enough, but it is necessary to remember that the sac lies up under the internal canthal ligament. It is well to make the incision all the way down to the bone. The periosteum from the orbit divides into two layers, one behind the sac to form the floor of the lacrimal fossa and the

other passing in front of it. This is the lacrimal fascia. The sac and the floor are intimately connected. After the incision has been made down to the bone one should push back the tissues and feel for the anterior lacrimal crest. After the anterior lacrimal crest has been discovered one should dissect upward, and the internal canthal ligament will be found. (The most important thing in surgical treatment of the sac is good light.)

When the inner canthal ligament has been cut through, one will find the sac exposed. The third landmark is the posterior lacrimal crest. The reason one chooses a point 3 mm. in and 3 mm. up in making the incision is that in front of the anterior lacrimal crest course the angular artery and the vein. By going beyond 3 mm. one is apt to strike them and to cause much bleeding. After the ligament has been cut through, the sac will be found directly under it. In doing a dacryocystorhinostomy one should pull the sac over to the side away from the nose and break through the bone of the lacrimal fossa, exposing the nasal mucous membrane. Some operators like to use an electric trephine to make the opening into the nose. The upper part of the anterior crest can be cut through with the bone trephine after the vessels have been pushed aside. One should have a good hold on the electric trephine so that it will not slip from the hand and injure the cornea. One should be careful not to go through the nasal mucous membrane with the trephine. The anterior tip of the middle turbinate bone must be anesthetized beforehand.

After the opening has been made down to the mucous membrane, the plug of bone is removed. The opening is then enlarged in order to make the aperture in the bone twice the size of the sac. An incision is then made in the mucous membrane so as to obtain two flaps. The sac is incised in the same way. The posterior flaps are first sutured together with a Yankower needle, and then the anterior flaps are sutured together.

In a simple extirpation the sac is lifted out of the floor, together with the periosteum. The sac is dissected free, the fundus attachments above being cut. The point of the scissors should be put into the lacrimal canal, and one should cut down as far as possible. The next step is to curet out as much of the canal tissues as possible and to pass a no. 15 or a no. 16 Bowman probe into the nose.

After the sac has been sutured to the mucous membrane (dacryocystorhinostomy) or removed (dacryocystectomy), one must suture the skin and the inner canthal ligament. The internal canthal ligament has been cut, and if it is not sutured back in place the orbicularis oculi muscle may pull the inner canthus away from the nose. The suture is passed through the skin, the outer portion of the canthal ligament, the attachment of the canthal ligament to the periosteum of the nose and the inner cut cutaneous surface and is tied with a surgeon's

knot. The skin is sutured with black silk. A small roll of bandage is placed over the incision in the sac. Before putting the dressing on, one should be sure to inspect the cornea. A drop of fluorescein should be placed in the eye to determine that the cornea is intact. A pressure dressing should then be applied and held in place with flamed adhesive tape, and a bandage should be put on top of this. After the bandage is in place, a tape around the head above and below the external occipital protuberance keeps the bandage from slipping up or down.

MUSCLES

All ophthalmologists are confronted at times with the problem of correcting squint, whether it is convergent strabismus or divergent strabismus. There are many causes for imbalance of the eyes, the principal one being a central defect in the fusion center of the brain. The second cause is probably physical; either the internal rectus muscles are strong and overdeveloped or the external rectus muscles are weak and underdeveloped. The insertion of the muscles is an important factor. With convergent strabismus the internal rectus muscles may be inserted farther toward the front than is normal or the external rectus muscles may be inserted farther backward. Sometimes no muscle is present, as in cases of Duane's syndrome, in which there is a band of fibrous tissue replacing the muscle tissue. There is also a condition known as strabismus fixus, with which a band of connective tissue is present together with the muscle. All these things enter into one's judgment as to the condition present and the manner of correcting it. A most important cause of strabismus is hypermetropia. A child who takes a + 7.00 sphere in each eye will accommodate more in looking at a distance than would a normal person in looking at his finger at close range. Such a child may go for a long period with the eyes perfectly straight, but he is unconsciously straining in holding the eyes straight in order to overcome the terrific converging power. The child may fall down or may have some illness, such as measles, whooping cough, scarlet fever or diphtheria, and the parents say that the illness or the accident is the cause of the convergent strabismus, whereas in all probability the weaker eye would have turned sooner or later without that particular event.

A number of years ago a girl was brought to a physician's office at the age of 18 months. Because the patient was from out of town, refraction was done with the aid of scopolamine hydrobromide. One-tenth grain (6 mg.) to the drachm is used, 1 drop being instilled and the process repeated in fifteen minutes. Sometimes another drop is instilled in one-half hour. In forty-five to fifty minutes one obtains almost complete mydriasis. The same results are obtained as when 1 per cent atrophine sulfate is used three times a day for three days.

This child under the influence of a mydriatic took a + 3.00 sphere in each eye, and allowing 0.5 D. for the tone of the muscle the child accepted a + 2.50 sphere in each eye. Since the child was only 18 months old, the mother was told that she was far-sighted, and exercises rather than glasses were advised. The mother was told to return in six months with the child. Two weeks later the child was seen with glasses on; so the physician made up his mind that if some one were going to put glasses on the child he would do it himself thereafter. If the hypermetropia is bad enough, the child will wear glasses and be perfectly happy with them.

It is important that strabismus be measured very carefully. A good routine must be employed for measuring a squint. The child should be induced to look at a light or a pin in all directions to see whether there is any limitation of motion. Treatment of paretic squint is different from that of concomitant strabismus.

When the child moves the eyes equally in every meridian the amount of strabismus is measured by the screen and cover test in the primary position at 6 meters and then at 25 cm., first with and then without correction. The amount of strabismus is measured with the patient looking up to the right, straight to the right and down to the right; then up to the left, straight to the left and down to the left. By measuring in different positions a vertical imbalance of the muscles may be readily detected. It is important to take the vision of the child both before and after mydriasis. About a year ago a 3½ year old child was seen by a physician. A question mark was put down for the vision because the child did not cooperate on the "E" chart and the examiner was not sure about her vision. He was called into court to testify. Another physician who had been consulted had obtained vision of 20/30 with the fixing eye and of 20/200 with the converging eye. The child was seen again later, and with the chart of pictures and a little time and patience it was possible to get the same vision that the other physician had obtained. In cases of strabismus one should always give the patient glasses if they are required and wait three to six months to see what the glasses will accomplish before considering an operation. In the meantime the orthoptist can give more benefit to this type of condition. He should train the child and try to bring the vision in the squinting eye up as far as possible. If it can be brought up to 20/20 the chances of success are much greater, for then the child has a greater desire for single binocular vision and fusion.

In cases of divergent strabismus one tries to put on as much minus correction as is necessary under mydriasis, because making the eye accommodate will often help the converging power and bring the eyes straight. If the degree of divergence is too high the effort is too great, and the child may be made uncomfortable or may allow the weaker eye

to turn out. In measuring the strabismus for distance and for near vision, if there is convergent strabismus of, say, 25 degrees for distance and 40 degrees for near vision, it means that there is convergence excess, or overaction of the internal rectus muscles, and the best result will be obtained by weakening the action of these muscles. On the other hand, if there is esotropia of 40 degrees for distance and of 25 degrees for near vision, there is divergence insufficiency, for the internal rectus muscles are not too strong, and the best correction will be achieved by advancing the external rectus muscles to bring the eyes straight. With divergent strabismus which measures 25 degrees for distance and 40 degrees for near vision, there is convergence insufficiency, and there is probably a weakness of the internal rectus muscles. Therefore, by resection of one or both of the internal rectus muscles a more efficient correction will be achieved. If there is divergence of 40 degrees for distance and 25 degrees for near vision, a tenotomy of the external rectus muscles will probably result better, as the internal rectus muscles have insufficient power in this form of divergence excess. This assumes a normal near point of convergence and that no secondary deviation exists.

The age at which to operate is important. It is the opinion of most operators today that every child with strabismus should be operated on before he is 6 years old if one can get the consent of the parents. There is no longer the fear of the anesthetic that formerly obtained. At the Massachusetts Eye and Ear Infirmary it was once felt that the thymus gland had a great deal to do with death during anesthesia, and McMillan used to take a roentgenogram of the chest of every patient before the anesthetic was given to determine whether the thymus was enlarged. If it was found to be enlarged, a series of roentgen treatments was given to reduce it. That was about fifteen years ago. Today the child is given a thorough physical examination to determine his ability to take the anesthetic. It is my personal opinion that every patient, unless he requests otherwise, should be given a general anesthetic for operation on the muscles. No matter how much one anesthetizes, there is pain associated with pulling on the muscles, and when cocaine or procaine hydrochloride is injected into the muscles the action of the muscle is altered just as much as if the child were given a general anesthetic. The tissues become boggy, the muscle becomes edematous and there is a greater possibility for the suture to slip.

In doing a resection or a recession it is always best to operate first on the muscle one wishes to recede or weaken. In cases of convergent strabismus one should recede the internal rectus muscle first. One should never recede the internal rectus muscle more than 5 mm., because the patient's power of convergence may be destroyed. A perfect result may be obtained for distance, but the child will suppress the image in

one eye, or, in fact, he may close one eye for near work. One should never do a tenotomy of the internal rectus muscle. Twenty-five years ago this was done, together with an advancement of the external rectus muscle. Good results were achieved at first, but in two to three years the eyes frequently would turn out. It is possible to do a tenotomy of the external rectus muscle, however, and to obtain good results. On the other hand, recession of the external rectus muscle is probably a more accurate procedure.

Theoretically one obtains 5 degrees of correction for every millimeter of recession or resection of a muscle. One arrives at this figure by measuring the globe, which is about 72 mm. in circumference. Since the circumference of the globe is 360 degrees, one divides 360 by 72; the result is 5. This, however, cannot be relied on, because of variation in the strength of muscles and also in the points of insertion. It is impossible to lay down any rule for strengthening or weakening a muscle before operation. This must be done at the time of the operation and depends on conditions as one finds them plus surgical judgment based on careful preoperative measurements.

It is satisfactory to use avertin with amylene hydrate, evipal or pentothal sodium as the anesthetic, if enough is given. Some operators have found that in using avertin with amylene hydrate the anesthetist is afraid to give enough, so that often it has to be supplemented with ether to keep the patient quiet on the table.

The face is cleansed with soap and water. The lids, brow and upper part of the cheek are painted with 3 per cent iodine and wiped off with 75 per cent alcohol. The conjunctival sac is flushed with warm boric acid solution. A speculum is then inserted, spreading the lids apart, and the conjunctival sac is again flushed with the same solution. It is well at this point to hesitate and ask oneself which eye shall be operated on and whether one is to recede the internal rectus muscle or resect the external rectus muscle. This may save the surgeon the embarrassment of operation on the wrong eye or on the wrong muscle. In operating on the internal rectus muscle the eye is pressed out toward the outer canthus with a squint hook. The points of insertion of the muscles are: internal rectus, 5.5 mm. from the limbus; inferior rectus, 6.5 mm.; external rectus, 6.9 mm., and superior rectus, 7.7 mm. However, if one remembers 5, 6, 7 and 8 mm. it will be near enough.

The conjunctiva should be picked up over the muscle. It is very important in picking up the conjunctiva to pick it up above or below and not over the muscle, lest the muscle be included. This is mentioned because almost every one has seen a surgeon cut the conjunctiva and, on looking for the muscle, find that it is not there because it has been cut with the conjunctiva. One should be sure that nothing but the conjunctiva is cut in the first incision. Tenon's capsule lies behind the

conjunctiva and is inserted into the sclera about 2 to 3 mm. back of the limbus, so that the muscle that arises 5 mm. back is surrounded by Tenon's capsule. If one tries to pick up that muscle with the squint hook, Tenon's capsule will interfere. One should apply a Lester forceps above or below the muscle, spread the points and then close them, picking up Tenon's capsule, and make a nick in Tenon's capsule. Then the hook may be introduced through this cut and the muscle picked up. The tendon of the internal rectus muscle is very short, measuring less than 5 mm. in length. If the muscle back of the tendon is cut and the suture inserted, the suture is likely to pull out. The suture should be put in the matrix close to its insertion in the sclera; then the surgeon can use one loop of the suture, and it will not pull out. It is usually best to put in two sutures to flatten out the tendon, starting from the center and coming over to the lower side with one end of the suture and starting from the lower side and going to the center with the other. This should be repeated with the upper suture. A Prince forceps should never be put on a muscle which is to be receded, because that clamp compresses the muscle fibers and bruises them. It may cause the muscle in front of it to slough. In resecting a muscle, however, when one puts the clamp on the muscle one cuts back of the forceps and hence can do no damage.

Another reason why it is a good thing to put the sutures close to the muscle insertion is that after the tendon has been cut and one has measured back 5 mm. one is more apt to get the full 5 mm. of recession. The point at which the suture is put into the end of the muscle is important in determining how much the muscle will be receded.

The next step is to insert the needles into the sclera. The sclera at the back of the eye, where the optic nerve enters, is about 1 mm. thick. Where the muscle is inserted, it is about 0.6 mm. thick. It is important always to keep the point of the needle in view, because if it passes out of view it is in the choroid. Usually one holds the needle with the needle holder just back of the center. In putting it into the sclera, however, the needle should be picked up just back of the point, because by catching it in that way one has a better purchase on it. In using a double-armed suture the surgeon should insert one needle into the sclera, starting from the level of the insertion above, and come out near the center; the lower suture should start from the level of the insertion below, the needle being pointed to the center. If he uses no. 000 ten day catgut, he should tie the suture in place in the sclera and cut off the ends. If he uses black silk, he should continue with this suture up to the stump, coming out through the stump, then through the conjunctiva and back to the conjunctiva at the caruncle, so that when the suture is tied the two layers of conjunctiva are brought together over the stump. When the eye comes around straight after the black silk suture is used, the suture comes out through the conjunctiva over the

old insertion. Otherwise the suture would be tied on the sclera behind the caruncle and would be most difficult to remove. Children for whom black silk is used will scream when one tries to remove the suture, and often one cannot get the whole suture out the first time and has to have the child come back again. In fact, one may have to anesthetize the child to remove the sutures. In my opinion it is best always to use no. 000 ten day plain catgut for the muscle recession and to close the conjunctiva with plain catgut.

In doing a recession one should always free the muscle from Tenon's capsule attachment. Furthermore, one should pick up the conjunctiva to the nasal side and free the caruncle from the underlying muscle. The incision should be made temporal to the plica semilunaris. No one considers the caruncle an attractive part of the physiognomy, but when it is sunken in with the receded muscle the eye is unsightly.

In resecting the external rectus muscle one should not put the hook in and push the eye inward, because in so doing the sutures that have been put in for the recession may be pulled out. The eye should be pulled in with forceps. It now turns in, and the external rectus muscle is ready for operation. Seven millimeters from the limbus the conjunctiva should be picked up and incised. Then the conjunctiva should be spread. The tendon of the external rectus muscle is embedded in Tenon's capsule. There is no excuse for not picking up the muscle on the first attempt with the hook. One should open Tenon's capsule and pass the hook under this capsule and the muscle. After exposing the muscle and freeing it from Tenon's capsule one should undermine the conjunctiva freely nasally and temporally and put on the Prince forceps. It does not make much difference how the forceps is put on, from below or above; the important thing is that the muscle should be spread out evenly over the blade of the forceps. The muscle should not be cut too close to the sclera, because it will be more difficult to put in the sutures through the stump. One and one-half millimeters of tendon should be left at the stump. The Reese method of resecting the muscle is the one generally in use.

In the Reese method the muscle is pulled out with a Prince forceps. In applying the sutures, Reese puts both needles of a double-armed suture of no. 3 twisted silk through the center of the muscle from within out through the temporal edge of the conjunctiva, back through the stump and then through the nasal edge of the conjunctiva. Then two wing sutures are placed: The upper one goes through the nasal conjunctiva, through the stump, over through the edge of the muscle and through the temporal edge of the conjunctiva; the lower comes through the conjunctiva, stump, muscle and conjunctiva and then out. After the sutures are placed, one cuts off the muscle beyond the sutures, being careful not to cut the sutures. When the central suture is tied the

cut end of the muscle will be covered with the conjunctiva, and the conjunctiva will be turned in under the end of the muscle against the stump. The wing sutures are worth little. They do not do much to hold the muscle. With the Reese procedure there is often postoperative slipping, and for that reason it is better, according to some operators, to make use of the method in which two double-armed sutures are employed. One needle of the first suture goes through the center of the stump and then through the center of the muscle as far back as is deemed necessary. The other needle goes through the lower edge of the stump and through the lower edge of the muscle, and then the same procedure is followed with the other suture above. Both sutures are tied, and if they are tied right over the muscle itself they bind it to the stump. If this is done there is little likelihood that the muscle will slip. With the latter method better results seem to be obtained. The conjunctiva is closed with interrupted or continuous catgut suture. Black silk may be used, but one should be sure to come through the conjunctiva with the muscle suture to facilitate its removal.

Care is necessary in resecting the muscle, because in some cases the inferior oblique muscle has its insertion under the external rectus muscle, and this muscle may be inadvertently damaged.

In doing a tenotomy of the inferior oblique muscle for vertical imbalance, one should make an incision in the conjunctiva over the external rectus muscle and below it and go back with the muscle hook to pick it up. Then one should put another hook through the external rectus muscle to be sure that it is intact. It is better never to go below at the margin of the orbit to weaken the inferior oblique muscle. If, however, a myomectomy of the inferior oblique muscle is done at the lower margin of the orbit, one must remember that the inferior oblique muscle arises at the margin of the orbit, just back of the opening of the nasolacrimal canal, on a perpendicular line dropped from the superior orbital notch, and goes back up to be inserted into the eyeball behind the equator.

A great many surgeons in operating on the inferior oblique muscle at the lower border of the orbit make the incision too far back and cut off the muscle beyond its origin. When that is done, they insert the hook and cannot find the inferior oblique muscle. To find the origin of that muscle one should make the incision right on the margin of the orbital rim. If one has the inferior oblique muscle and pulls out with the hook the eye will turn up. If one has the inferior rectus muscle the eye will turn down. One may use either the conjunctival or the cutaneous route. By the cutaneous route one may cause a keloid or a slight scar, which is a disadvantage, though this route is easier than the conjunctival.

Dunnington stated that in operating for vertical imbalance, for instance, in a case of paresis of the right superior rectus muscle, if the

patient fixes with the paretic eye one should do a tenotomy of the inferior oblique muscle of the opposite eye. If the patient fixes not with the paretic eye but with the eye with the overacting inferior oblique muscle, one should resect the superior rectus muscle of the paretic eye. The patient will be much more comfortable.

Resection or recession of the superior or the inferior rectus muscle is performed in the same way as resection or recession of other muscles.

Other procedures are used with success in operating on the ocular muscles, but the one or two procedures that have been found satisfactory are described. No attempt is made to describe all the methods.

DETACHMENT OF THE RETINA

In operating for detachment of the retina it is essential to consider the anatomy of the eyeball. One is concerned principally, of course, with the retina. It is attached in front at the ora serrata and behind at the optic nerve. Anteriorly in many eyes (when there has been some uveitis, when the person has had some diseased condition or even when no cause can be found) the cells near the ora serrata contain vacuoles showing degenerative changes. These are called von Blessig's spaces (sometimes referred to as the spaces of Ivanoff). The rest of the retina is loosely held in place by the pressure of the vitreous. If the eye receives a blow, it is easy to conceive that these degenerated cells will tear. When there is a tear there is an opportunity for the fluid to get back of the retina, thereby detaching the retina and pulling it away from the choroid.

No entirely satisfactory explanation is available as to how the tear contributes to the detachment, but it is known that the retina falls down into the vitreous. It is replaced by evacuating the subretinal fluid and at the same time causing an irritation of the choroid in order to set up a plastic choroiditis. When healed, the retina is held in place by the scar tissue formed by the plastic choroiditis. Many operations for detachment of the retina fail because, although a barrage of diathermy is laid down over the area of detachment, the fluid is not withdrawn and the retina cannot attach itself to the choroid. Many surgeons feel that the holes made by Walker or Šafář needles permit enough subretinal fluid to come out to let the retina go back into place, but in the experience of many others this is not always so. If the retina is 2 to 3 mm. away from the inflamed choroid it will not grow fast to the choroid. In every case it is well to make a 1 mm. trephine opening in the most dependent part in order to evacuate the subretinal fluid. A little girl had almost complete detachment of the retina, the replacement of which was felt to be impossible. Many floating opacities were present. Diathermy was used; about 2.5 cc. of subretinal fluid was withdrawn, and much to the amazement of the operators the retina went back into place and stayed there.

Extremely important is localization of the long posterior ciliary artery, the short posterior ciliary arteries and the venae vorticosae. The two long posterior ciliary arteries go to the front of the eye from behind and inside the sclera under the external and internal rectus muscles. The short posterior ciliary arteries come up in the back of the eye around the optic nerve. Wagenman, in experimenting on dogs, tied off the short posterior ciliary arteries and produced complete choroiditis of the back of the eye. He then tied off the long posterior ciliary artery of one side and caused anterior choroiditis of that side. When he tied off both long posterior ciliary arteries he obtained complete anterior choroiditis and a cataract.

In many cases of detachment for which operation has failed it is felt that the area under the external and internal rectus muscles has not been carefully avoided with the diathermy. Putting a needle over this area and destroying the artery is the same as tying it off. The importance of this long posterior ciliary artery should not be lost sight of. Whether ignipuncture, surface diathermy, Šafář or Walker needles, Schoenberg's or Gradle's needle, a caustic or the thermaphore is used, the principle is the same—to set up plastic choroiditis. If this is done and the retina goes back into place, it does not matter what method is used; the essential things are that a plastic choroiditis should be caused and the subretinal fluid allowed to escape. Šafář also injected mercury cyanide around the macula in order to set up choroiditis and reattach the retina. Halfway between the insertion of the inferior oblique muscle and the optic nerve is the external localization of the macula.

OPERATION FOR PTOSIS

Ptosis is a condition with which ophthalmologists are confronted from time to time. A patient may have drooping eyelids. If the droop is recent, one tries to find the cause—whether it is a congenital defect or is caused by syphilis, infected sinuses or a general condition—and then have that cause treated and eradicated. With ptosis of several years' duration the problem of surgical correction arises. There are dozens of different operations, including the Tansley-Hunt operation, the Hess operation, the Wheeler operation, the Reese operation and the Trainor operation.

In the course at the New York Eye and Ear Infirmary an attempt is made to consider four elementary methods of correcting ptosis. Of these four methods the first and the second are rather similar. The first is shortening of the lid. The second is resection or shortening of the levator palpebrae superioris muscle. The third is utilization of the superior rectus muscle of the eye. The fourth is utilization of the occipitofrontalis muscle. These are the only four ways to raise the

lid. An attempt will be made to describe one operation by each of these methods which has been found effective. If the reader does not like one type, he may use another one, modify it or change it, but there are no other ways of correcting this condition than these four principles mentioned.

When a patient has bilateral ptosis it is important to know whether there is any remaining action of the levator muscle; whether there is complete paralysis or paresis of the levator muscle, or whether it is simply paresis of Müller's muscle. When the eyes are closed and then opened, that is the action of the levator muscle. If, as with fright or anxiety, the lids go up 2 mm. more than usual, that is the action of Müller's muscle. By holding the eyebrows and asking the patient to open the eyes the action of the levator muscle can be determined, because the occipitofrontalis muscle is prevented from acting.

Another important fact is that a patient may have marked apparent ptosis of one eye, so that the lid appears to hang down over the cornea. This may not be ptosis; it may be paralysis of the superior rectus muscle of the other eye with a spasm of the inferior oblique muscle of the affected eye, turning the cornea up under the lid.

James White advised that one should always measure the muscles before correcting the ptosis. That brings up the question of what to correct first, the ptosis or the muscles. White advised correction of the muscles first. Weeks found that if he corrected the muscles first the patient became discouraged because his family could see little change, and he might never return for correction of the ptosis. Although Weeks measured the muscles first, he corrected the ptosis before he operated on the muscles. When the lid is raised and the strabismus is apparent, the patient is most anxious to have it corrected also.

A patient may be seen with ptosis which is bilateral but of the outer half of the eye only. If one performs resection of the outer half of the tarsus and raises the outer half of the lid the eyes will be perfectly satisfactory.

Another thing to be considered before operating on ptosis is whether the superior rectus muscle is healthy or not. The examiner should hold the lids up and have the patient squeeze them together in order to determine the action of the superior rectus muscle. Ordinarily the eyes will roll up (Bell's phenomenon). In examination of the patient it must be determined that the superior rectus muscle is normal.

Another point concerning ocular operations for ptosis is that the highest part of the upper lid is not at the center of the lid but at the junction of the inner third with the outer two thirds. The lowest part of the lower lid is at the junction of the outer third with the inner two thirds. The significance of that is as follows: When an eye is operated on and notching of the eyelid results, if the notch occurs in the center

the eye will be worse looking than if it occurred at the junction of the inner third with the outer two thirds.

Several types of operations for ptosis will now be considered. The first is the Kuhnt-Heiserath operation. This is usually done for ptosis resulting from trachoma. The upper lid is everted with an Ehrhardt clamp. An incision is made along the upper edge of the tarsus and another incision below, but always 2 mm. from the border. One should never make this piece of tarsus at the lid margin less than 2 mm. wide; otherwise notching of the lid will occur. The tarsus, having been outlined, is excised, care being taken to dissect it free from the overlying muscle of the orbicularis oculi. The cut edges are then sutured. A suture is put through the upper cut surface. The suture needle on the conjunctival side goes through the tarsus below and out through the skin. The other suture needle goes in front of the tarsus and out through the skin. If the sutures are brought down in front of the tarsus the conjunctiva is buried in front of the tarsus below and a sharp rim of tarsus will have formed. If both sutures are entered from behind the tarsus, a fold of conjunctiva on top of the tarsus will result. If one suture is put through the tarsus and the other in front, the two surfaces will be brought into perfect approximation. Three sutures are placed and tied over the front of the lid just above the lashes, over rubber pegs. This will correct the ptosis caused by trachoma. The ptosis of trachoma is thought to be due to the action of the toxins and to the weight of the lid from the swollen tarsus. That is the operation used to shorten the lid.

The levator palpebrae superioris muscle comes from the fibrous ring, or annulus of Zinn, at the back of the orbit and is inserted into the skin on the front of the lid. Whitnall said that it is not inserted into the tarsus. Weeks found that there were a few fibers going into the tarsus, but very few. There is a muscle, however, attached to the upper border of the tarsus—Müller's muscle—which is a smooth muscle. It arises from the tendon of the levator palpebrae superioris muscle. The septum orbitale acts as a support to the levator muscle, and when the septum orbitale is cut it lets the lid droop down on the eye. This may happen in operations or injuries below the brow.

The second operation is Wheeler's—resection of the levator muscle or Blaskovicz' operation or a combination of the two. The lid is everted with an Ehrhardt clamp. The conjunctiva is cut at the upper limit of the tarsus and is dissected back from the upper border of the tarsus to the upper fornix. This exposes Müller's muscle, attached along the upper border of the tarsus. Depending on the amount of correction he wanted, Wheeler marked off a portion of the tarsus. An incision is made, accordingly, across the tarsus. Keeping close to the back of the skin in order to get the levator tendon together with the tarsus, one dissects up as far as the reflection of the septum orbitale. Sutures are then placed

much the same as in the Kuhnt-Heiserath procedure except that one goes through the levator tendon at the upper border of the tarsus. The conjunctiva is later brought down and sutured separately. Blaskovicz concluded that he did not obtain a pronounced enough result with this type of operation. In the Machek-Blaskovicz operation one dissects farther back and places the sutures some distance above the tarsus in the levator tendon, brings them down in front of the lower, cut part of the tarsus and ties them on the skin above the eyelashes over a peg to shorten the muscle. The remainder of the muscle is cut off and thrown away. The principle of this operation is to secure the fibers of the levator muscle above their insertion and bring them down and bury them in front of the remaining tarsus, thereby shortening the muscle tendon. Resection of the levator muscle is not as effective as it should be because so much has to be done to get little effect. The best effects are obtained with the Wheeler operation in cases of Horner's syndrome with slight ptosis. In such cases the operation is successful. With a marked degree of ptosis it is necessary to do more than a simple resection of the levator muscle.

The third operation utilizes the superior rectus muscle. Motais' or Kirby's modification is this type. After a bone plate has been placed under the upper lid, 7 mm. above and a little nasal to the center, an incision 10 mm. long is made on the cutaneous surface. This cut is made right down on the tarsus, and then a tunnel 5 mm. wide is dissected all the way down to the hair line of the lashes. Through this tunnel the superior rectus muscle tendon slip will come and will be sutured in place at the lid margin. The upper border of the tarsus will show through the cutaneous incision. In making the cut it is necessary to cut through the skin, the levator tendon and the fibers of the orbicularis oculi muscle. Attached to the upper border of the tarsus are the fibers of Müller's muscle. The fibers of Müller's muscle are cut, and underneath them will be the conjunctiva. One dissects back between the conjunctiva and Müller's muscle until the upper fornix is reached. The bone plate is then removed; a speculum is inserted between the lids, and the eye is rolled down by putting a suture through the conjunctiva at the limbus. Eight millimeters back of the limbus one makes an incision 15 mm. long in the conjunctiva. The conjunctiva is then spread apart; Tenon's capsule is incised, and a hook is placed beneath the superior rectus muscle tendon. In any of the rectus tendons there is a matrix of the tendon close to the sclera. This is the strongest part of the tendon to hold a suture. One picks up the muscle and puts a grooved director beneath it to hold it away from the eye. Incisions are then made to divide the muscle into a center half and two outer fourths. A suture is put through the tendon of the center half, close to the sclera, and the muscle is cut

free from its insertion, the two outer fourths being left attached. It is then necessary to bring the central tendon of the superior rectus muscle around the superior fornix of the conjunctiva through the cut Müller's muscle at the upper edge of the tarsus, through the cut in the levator muscle, and down in front of the tarsus through the tunnel that was made to the lash line. The needles are passed, the eye of the needle foremost, around the back of the fornix of the conjunctiva, over the tarsus and through the tunnel to the lash line, where they penetrate the skin above the lashes. The suture is tied over a rubber peg in front of the lid. The weight of the lid is too much at first for the tendon slip to hold; so a double-armed suture is put through the aponeurosis of the levator tendon and the septum orbitale above the cutaneous wound, brought down through the tunnel and out through the skin and tied over a rubber peg above the tendon suture of the superior rectus tendon. It is the aim of every operation for ptosis to insure that the upper lid will be at the upper margin, or limbus, of the cornea when the sutures are tied. The upper lid is ordinarily 1 to 2 mm. above the undilated pupil. After the operation the lid usually sags a little for the first two or three weeks; then it sinks from the position at the limbus to its normal position.

There are other methods of utilizating the superior rectus muscle. The simplest one is the Trainor operation. Wiener described this well in his latest book. With a pair of scissors a cut is made a little to the nasal side of the upper border of the tarsus, with the lid everted, and a flap of the superior border of the tarsus is taken. A forceps is passed through the conjunctiva and under the superior rectus muscle; the suture placed at the cut end of the tarsal flap is grasped and drawn under the superior rectus muscle, and then the tarsal flap is sutured back in place. The superior rectus tendon then comes down over the flap of tarsus. If the superior rectus muscle is active this operation is effective and takes only a few minutes to do.

The next operation is utilization of the occipitofrontalis muscle. The Reese operation can be used effectively when the others have failed or when there is no active superior rectus muscle. In cases of complete paralysis referable to the third nerve one should never do this or any operation. In these cases the lid is lifted up into place and usually cannot be completely closed. The cornea is left unprotected because it cannot be moved in any direction and find cover. Panophthalmitis may result from such exposure, and the eye will be lost. If there is complete paralysis of the external muscles of the eye one should never operate for ptosis. A few years ago a little girl had a similar ptosis so that she played about holding the lid up with her finger. Edmund Spaeth saw the child, and when he was asked about operating on her he suggested that no operation be done; so she was given a crutch glass to use.

In Reese's operation a cutaneous incision is made along the palpebral fold of the upper lid its entire length. This incision is 4 mm. above the palpebral fissure at each end and 6 mm. at the center. This palpebral fold should be retained. If it is absent one should try to make it. The first step is to lift up the lower edge of the skin and dissect down 2 mm.; the second is to lift up the upper skin flap and undermine up 4 mm. One should be very careful to stay close to the skin. This exposes fibers of the orbicularis oculi muscle. The center 10 mm. of orbicularis muscle attached to the tarsus is left in place. Two flaps of muscle, an inner and an outer, are then outlined and dissected up. A double-armed suture is next put through the upper part of the tarsus, just nasal to the center of the attached obicularis muscle, and brought out above the brow but not yet tied. The Reese knife is introduced 25 degrees first to one and then to the other side of this center suture at the upper hair line of the brow. A suture is put through the ends of the orbicularis muscle flaps, and the ends of the suture are placed through the hole in the Reese ptosis knife. Each muscle flap is brought out through the tunnel made by the ptosis knife in the brow. One should be sure to go in through the occipitofrontalis muscle with the Reese knife above the brow. The muscle flap is sutured in the wound made by the ptosis knife, and the amount of muscle that protrudes is cut off. If the muscle does not quite reach one may suture across the skin, making a bridge. The tongue of the muscle is held in position by tying its suture over this bridge. The muscle flap becomes fibrous tissue, not muscle, and the central suture will hold the lid in place until the muscle flaps grow firmly into position. The central suture is tied last over a rubber peg, the upper lid being raised to the upper margin of the cornea.

Concerning dressing, Wheeler used a cone of wet cotton half filled with petrolatum, which was put on the eye and strapped in place with adhesive tape.

Dressings must be repeated every twenty-four hours, because the cornea is exposed, and if the dressing rubs the cornea it may ulcerate. Meyer Wiener recommended a flamed adhesive tape placed on the cheek so that the lower lid is pulled up over the eye and the adhesive tape is attached above to the brow; thus any tension is taken away from the upper lid. It is most important dressings be done every day. A child was operated on at a certain hospital; the surgeon went away for a week-end and left the dressing to be changed by the house surgeon. It was not changed for several days. The child complained of pain and was given codeine sulfate. When the dressings were removed both corneas had ulcerated because the dressing had rubbed them.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Conjunctiva

TRANSMISSION OF SWIMMING-BATH CONJUNCTIVITIS TO MONKEYS. L. A. JULIANELLE, Am. J. Ophth. **23:** 554 (May) 1940.

After discussing the methods and conditions of his study of the transmission of swimming bath conjunctivitis in monkeys, Julianelle gives the following summary and conclusions:

"1. Swimming-bath conjunctivitis may be transmitted experimentally to monkeys (M. rhesus). 2. The experimental infection appears as a follicular conjunctivitis following an incubation period of a week or more, and it may last for several months. 3. The experimental disease is indistinguishable from experimental trachoma and experimental inclusion blennorrhea in the same animal. 4. The infectious agent of swimming-bath conjunctivitis is filterable under appropriate conditions through collodion membranes measuring 0.65 μ. A. P. D. [average pore diameter 0.65 micron]. 5. Since bacteriologically sterile filtrates of the human tissues retain their specific infectivity, the infectious agent is considered to be a virus. 6. No evidence was obtained of the existence of mutually protective immunity between experimental trachoma and experimental swimming-bath conjunctivitis. 7. The interrelationships of the inclusion-bearing diseases of the conjunctiva are discussed in brief."

W. S. REESE.

INFLUENCE OF VITAMIN A DEFICIENCY ON THE DEVELOPMENT OF RECURRING SEASONAL ALLERGIC KERATOCONJUNCTIVITIS (SCROFULOUS?). J. FRONIMOPOULOS, Klin. Monatsbl. f. Augenh. **104:** 1 (Jan.) 1940.

The author presents the result of his detailed clinical research with vitamin A in various forms, including synthetic preparations. A number of tables are added. He found relative A hypovitaminosis coupled with undernourishment in the majority of 41 patients. The presence of the hypovitaminosis was established by measuring the vitamin A content in the blood serum and by determining the dark adaptation. Keratinized epithelial cells, observed by Sweet and K'ang, could not be detected in the smears taken from the bulbar conjunctiva for determination of the hypovitaminosis. The vitamin A content in the blood frequently rose, even without administration of the vitamin, as soon as the ocular inflammation had subsided, but it never reached the physiologic standard. Recurrences were often observed in these patients, whereas they did not take place in patients with allergic (scrofulous) keratoconjunctivitis in whom the serum content was normal after administration of vitamin A. This disease may develop in a few persons with tuberculous allergy in the absence of A hypovitaminosis. A physiologic content of vitamin A in

the blood and improvement of the dark adaptation were observed after daily injections of 12,000 to 48,000 international units of vitamin A for several days. Ocular inflammation disappeared simultaneously in most patients. There were some recurrences notwithstanding this therapy. Allergic (scrofulous) keratoconjunctivitis was far more frequent directly after the first World War, as a result of improper nutrition, than in recent years. Because of vitamin A deficiency the epithelial cells of the conjunctiva and the cornea lose their physiologic function and defensive property.

K. L. STOLL.

Comparative Ophthalmology

BLINDNESS IN CATTLE DUE TO PAPILLEDEMA. J. O. WETZEL and L. A. MOORE, Am. J. Ophth. **23:** 499 (May) 1940.

Wetzel and Moore performed experiments on 6 calves and give the following summary and conclusions:

"1. Blindness due to constriction of the optic nerve and associated with papillary edema has been observed in six calves on an experimental ration.

"2. The constriction of the optic nerve appears to have been caused by faulty development of the bony canal, probably due to increased intracranial pressure.

"3. These ocular alterations were associated with epileptic-like seizures and wobbly gait.

"4. The evidence indicates that these ocular manifestations are of nutritional origin and probably due to deficiency of vitamin A in the rations."

W. S. REESE.

Cornea and Sclera

SALZMANN'S NODULAR CORNEAL DYSTROPHY. E. B. MUIR, Am. J. Ophth. **23:** 138 (Feb.) 1940.

Muir gives the following summary of a case.

"A case of bilateral Salzmann's nodular corneal dystrophy is presented. The occurrence of the large node on the left eye antedated the smaller nodes on the right by nearly 50 years. The appearance of the small nodes on the left, both before removal and microscopically, suggested their age to be approximately that of the nodes on the right eye. While previous phlyctenular keratitis might have played a role in the etiology of the large vascularized node on the cornea of the left eye, there was no evidence of this factor to be found on the right.

"The treatment advocated by previous essayists, surgical removal of the nodes, was used and found effective."

W. S. REESE.

CORNEAL TRANSPLANTATION. J. W. MCKINNEY, Am. J. Ophth. **23:** 371 (April) 1940.

McKinney reports 16 cases of corneal transplantation. He discusses these from the standpoint of preoperative and postoperative obser-

vations, of operative technic and of findings and results. He gives the following summary:

"1. Sixteen cases of corneal transplantation are reported.

"2. Preoperative factors which influence the course of the graft and give an indication of the probable visual outcome are recorded, the significance of the amount of leucoma in the cornea of the host being especially stressed.

"3. The technique of partial penetrating keratoplasty as developed by Castroviejo, which was followed in this series of cases, is described.

"4. The operative findings and postoperative observations are discussed, the latter with particular reference to nutrition of the graft.

"5. A classification and criteria for evaluation of the results are presented."

W. S. REESE.

STRIATED HERPETIC SUPERFICIAL KERATITIS AND INTERMITTENT OPHTHALMOMALACIA. R. SCHMIDT, Klin. Monatsbl. f. Augenh. **104:** 213 (Feb.) 1940.

Referring to his former report on 4 cases of striated herpetic superficial keratitis, the author adds 5 additional cases. The ages of the patients ranged between 17 and 75 years. The cause was an ordinary cold in 1 case and a superficial lesion of the cornea in 2; in 2 the keratitis followed extraction of a cataract. In 2 cases the stripes occurred with punctate keratitis. Corneal sensitivity was missing or distinctly diminished in 4 cases. The intraocular tension was lowered in 2. In 4 cases scrapings of the cornea were taken; in 2 they produced a positive result when inoculated into the corneas of rabbits. The negative results may be attributed to faulty technic, as the clinical course of the disease was distinctly that of a herpetic condition. The duration of the disease ranged between six days and four weeks.

Ophthalmomalacia was observed in 1 patient, aged 63, after extraction of a cataract. The streaks were located below the corneal epithelium; they were broader than in the other patients, and they showed club-shaped thickening in some places. The overlying epithelium was slightly raised. The sensitivity of the cornea was reduced, and decided intraocular hypotony existed, the tension amounting to less than 10 mm. of mercury. The condition lasted for several months. Inocculation on rabbits' corneas gave negative results. A table contains a record of the different appearances of striated herpetic superficial keratitis and ophthalmomalacia.

K. L. STOLL.

KERATOCONUS AND INJURY: REPORT OF A CASE. J. JUNG, Klin. Monatsbl. f. Augenh. **105:** 26 (July) 1940.

A number of cases have been reported in which keratoconus followed an injury after several years. Transient keratoconus of traumatic origin was observed by de Schweinitz. Authors agree that tearing of Descemet's membrane causes keratoconus after the eyeball is bruised, the tear being the primary cause. In genuine keratoconus, on the other hand, tears appear secondarily. Jung reports the case of a man aged 27 whose left eye was struck by lime. Only a slight lesion of the

cornea resulted, and the man was able to resume work after one week. Two months later irregular astigmatism of 7 D. had developed and the cornea had become conical. Discussing whether the reasons put forward in support of the traumatic origin were valid, Jung decides in the negative. The keratoconus, he believes, existed before the accident but was overlooked because of the unusual features of the case. Generally speaking, however, Jung concedes that keratoconus may develop as a result of bruising.

K. L. STOLL.

FIVE YEARS OF OBSERVATION OF PARTIAL CORNEAL TRANSPLANTATION. I. KOPP, Vestnik oftal. **16:** 305, 1940.

During the years 1934 to 1939 Kopp performed eighty keratoplasties. An analysis of 62 cases is given. The period of observation was from one to three years. In 59 cases the transplant took; in 3 cases it was lost. The transplant was taken from the enucleated eye in 31 cases and from a conserved cadaver's eye in 28, the average time of conservation being from thirty-five to forty hours after death. Favorable results were obtained about as often with the autograft as with the graft from the conserved eye.

In some cases, chiefly those in which a cadaver's cornea was used, the transplant took with no marked reaction on its part or on the part of the host. In other cases a severe reaction occurred.

Glaucoma is the basic cause of opacification of the transplant. Trachoma and symblepharon are secondary factors. Postoperative glaucoma is due to the formation of a broad anterior synechia as a result of late restoration of the anterior chamber. It is important to break up the adhesion early and to lower the tension either by administration of myotics or by operative intervention. In 1 case of keratoconus the transplant was lost.

Transplantation for trachomatous pannus gives good results, but the trachoma has to be treated first. In 13 of 59 cases of leukoma there was considerable clearing of the condition about the transplant. In 28 of 47 cases there was improvement of vision.

The postoperative course is benefited by osmotherapy and vitamin therapy.

O. SITCHEVSKA.

FIXATION OF TRANSPLANT IN KERATOPLASTY COMPLICATED BY PROLAPSE OF VITREOUS. S. PETRUNIA, Vestnik oftal. **17:** 187, 1940.

For fixtation of the transplant Petrunia devised a celluloid membrane, its shape corresponding to the shape of the anterior segment of the eye. It is kept in position at the ciliolimbal region by suction and by pressure of the lids. He also devised a special hook spatula (illustrated) by which he puts the transplant into the proper position through two openings made in the membrane at the horizontal axis, at about 3 and 9 o'clock.

After experimenting on rabbits Petrunia applied this simple method in 3 cases of complicated cataract; the prolapse of the vitreous was corrected at once.

O. SITCHEVSKA.

LATE RESULTS OF CORNEAL TRANSPLANTATION. E. A. PETROSIANZ, Vestnik oftal. **17**: 190, 1940.

Seventy-one cases of corneal transplantation observed from one to eight years are analyzed. In 65 (91.5 per cent) the cornea remained transparent. During the first two years opacification of the transplant occurred in 6 cases; in 5 it was due to increased intraocular tension and in 1 to late iridocyclitis. In 3 cases the transplant became semitransparent after an operation for glaucoma. In 14 cases the vision improved considerably with the correction of the refraction. Tables and photographs illustrate the article.

O. SITCHEVSKA.

Experimental Pathology

THE EFFECT OF THE INTRAVENOUS INJECTION OF NONSPECIFIC PROTEINS UPON EXPERIMENTAL CORNEAL ULCERS. E. GALLARDO and R. THOMPSON, Am. J. Ophth. **23**: 127 (Feb.) 1940.

Gallardo and Thompson give the following summary after discussing parenteral injection of foreign proteins:

"Lesions produced by the intracorneal injection of staphylococci into rabbits were consistently and significantly smaller when the injections were made into the corneae of rabbits previously given intravenous injections of typhoid bacilli. The protection appeared to be equally great 20 hours following a single 'shocking' injection of the nonspecific protein or 10 days following the immunizing injections when a slight but significant leukocytosis persisted. The nonspecific bacterial inhibiting power of the whole blood, the adjuvant power of the serum, and the direct bacterial inhibiting power of the serum all remained higher than normal in the immunized animals. The increase in capillary permeability resulting in the passage of fibrin into the aqueous fluid was also still present at the 10-day period.

"It seems likely that all these factors play a part in limiting the lesions in the 'shocked' and immunized animals and make it unnecessary to assume that the typhoid agglutinins per se are the protective factors."

W. S. REESE.

PHOSPHORUS METABOLISM IN THE LENS OF NORMAL AND PARATHYROIDECTOMIZED RABBITS. G. PIGNALOSA, Ann. di ottal. e clin. ocul. **67**: 927 (Dec.) 1939.

With the reduction of calcium and magnesium in the blood of parathyroidectomized rabbits an increase in blood phosphorus occurs, which produces an alkalosis. This is accompanied by a decrease of phosphorus in the soft tissues, while the phosphorus content of the bones is increased. Phosphorus plays an active part in the splitting of dextrose to lactic acid. One of the steps results in the production of phosphopyruvic acid, which splits to phosphoric acid and pyruvic acid, the latter being then reduced to lactic acid. The formation of phosphoric esters from hydrocarbons in the lens becomes less active with age and still less active in the process of senile cataract. Other researches in the author's department (University of Naples) have shown decreased

glycolysis in cases of incipient cataracta parathyroprivea, while the process is absent in the presence of complete cataracts of this type.

Eighteen animals were submitted to parathyroidectomy. All showed lens opacities after ten days. The lens of normal animals contains, on the average, 58.47 mg. of phosphorus per hundred grams. Of this, 20.87 mg. is inorganic and 37.6 mg. organic phosphorus. The amounts found in 6 normal rabbits were constant within narrow limits. When intact lenses were immersed in a solution of dextrose there was no difference in the relative amounts of organic and inorganic phosphorus as compared with those in lenses immersed in a saline solution. This shows that dextrose enters the intact lens, if at all, in amounts insufficient to affect phosphorus metabolism. The pulp of triturated lenses, however, has the power of forming phosphoric esters with dextrose, as is shown by the amount of inorganic phosphorus in a mixture of lens pulp and dextrose as compared with that in a mixture of lens pulp and saline solution.

The lenses of parathyroidectomized animals showed a reduction in total phosphorus content of 35 per cent, in inorganic phosphorus content of 30 per cent and in organic phosphorus content of 38 per cent. There was a slight relative increase in inorganic as compared with organic phosphorus, the ratio being 1 : 1.5 (normal lens, 1 : 1.8). Intact lenses immersed in dextrose solution showed a loss of inorganic phosphorus indicating an increased permeability of the lens capsule sufficient to allow dextrose to enter the lens. Triturated lens pulp, however, showed a definite decrease in power to form phosphoric esters with dextrose, to about half of that found with normal lens pulp. The loss of the power seems to be due to the loss of a ferment which is necessary to the process and which is of great importance in the splitting of dextrose.

S. R. GIFFORD.

RELATION BETWEEN IRRITATION OF PERIPHERAL NERVES AND APPEARANCE OF AGGLUTININS IN ANTERIOR CHAMBER OF RABBIT EYE. R. K. MIKAELYAN, N. ZHUK and I. VYGODSKAYA, Vestnik oftal. **16:** 301, 1940.

Two series of experiments were carried out in order to study the influence of irritation of the peripheral nerves on agglutinins in the anterior chamber. In the first series the rabbits were immunized with typhoid fever vaccine. On the day of the third injection the sciatic nerve was severed; on the following day the blood serum and the aqueous of the experimental and control rabbits were examined. In the second series of experiments the sciatic nerve was severed ten days before the immunization was started.

The agglutinins increased slightly in the blood serum and decreased slightly in the aqueous of the experimental animals. However, the authors conclude that the agglutination titer of the blood serum and the amount of antibodies which appeared in the anterior chamber were not sufficiently high to indicate any influence of irritation of the peripheral nerves on the agglutination curve for the blood serum and for the anterior chamber of the rabbit's eye.

O. SITCHEVSKA.

INFLUENCE OF CALCIUM DEFICIENCY ON THE SURVIVING RABBIT'S LENS: AN EXPERIMENTAL STUDY ON THE PATHOGENESIS OF CATARACTA TETANICA. GUNNAR VON BAHR, Acta ophth. **18:** 170, 1940.

The author's summary is as follows: "In a special artificial aqueous humor isolated rabbit's lenses were kept clear for several days. When the amount of calcium in the medium was diminished to half the normal or less, special lenticular changes might develop. Essential for this formation was the presence in the medium of an active substance, found in serum and above all in the blood corpuscles of the rabbit and, being a colloid, relatively resistant to a temperature of 60° C. The lenticular changes that appeared were radial striation and dots of the same type and situation as those seen in animals with tetany.

"The same effect as that induced by diminution of the calcium content was produced by the addition of small amounts of digitonin to the artificial aqueous humor.

"The results make the following pathogenesis of tetanic cataract probable: In tetany there is hypocalcemia. The hypocalcemia is followed by decrease of calcium in the aqueous humor. As a sequel to this the permeability of the lens capsule increases and this makes it possible for some unknown colloid in the aqueous humor to pass through the capsule and act upon the superficial layers of the lens cortex in such a manner that the characteristic changes are brought about."

O. P. PERKINS.

General

A SIMPLE OPTICAL APPLIANCE FOR USE WITH RESPIRATORS. P. KINMONT, Brit. J. Ophth. **25:** 122 (March) 1941.

Kinmont, a hypermetropic presbyope, has found that flat-sided spectacles for wearing inside respirators are painful, that the slightest tilting of the bifocal lenses causes distortion and that dimming is an intolerable nuisance. He has devised a flat steel spring to which is attached an inner eye wire to carry the requisite visual correction. The whole fitting is worn outside the eye piece of the mask, and the spring is kept in position by its own elasticity, which allows for accurate adjustment of bifocal lenses or cylinders.

The article is illustrated.

W. ZENTMAYER.

General Diseases

DYSTHYREOSIS COMPLICATED BY SERIOUS OCULAR CHANGES. W. REICHLING and H. MARX, Arch. f. Ophth. **141:** 374, 1940.

Five cases of toxic goiter associated with malignant exophthalmos are reported in detail. The exophthalmos was accompanied by chemosis of such extent and severity that portions of the bulbar conjunctiva became strangulated by the free borders of the lids. The strangulation produced clinically a deep furrow, anterior to which the conjunctiva appeared livid. The ocular changes were largely independent of the thyrotoxic symptoms. There was, for instance, no parallel between the

basal metabolic rate and the severity of the exophthalmos. In 1 case the exophthalmos developed after the thyroidectomy, which produced myxedema. In this case the ocular changes responded to treatment with thyroxin. Three patients showed metabolic disturbances characteristic of lesions in the hypothalamic region. The work of Marine, Rosen and other American investigators is cited, according to which the exophthalmos is probably the result of a disturbance of the relation between the hypophysis and the hypothalamic region.

The authors excised wedge-shaped pieces of conjunctival and subconjunctival epibulbar tissue in order to relieve the strangulation. The excisions were made in the meridional direction, preferably between the rectus muscles. The apex of the wedge lay near the limbus and the base near the equator of the globe, behind the margins of the lid. To be successful the excisions had to be done early and extensively. Histologic examination of the excised pieces revealed at first severe edema and later fibrosis and sclerosis of the subconjunctival tissue, with definite arteriolosclerosis. The authors believe that such wedge-shaped excisions saved the eyes of 2 patients.

Naffziger's method of orbital decompression in the treatment of malignant exophthalmos (Naffziger, H. C., and Jones, O. W.: The Surgical Treatment of Progressive Exophthalmos Following Thyroidectomy, *J. A. M. A.* **99:** 638 [Aug. 20] 1932. Naffziger, H. C.: Pathologic Changes in the Orbit in Progressive Exophthalmos, ARCH. OPHTH. **9:** 1 [Jan.] 1933) is reviewed in detail. Reichling and Marx say: "Our experiences justify the view that at least in some cases of malignant exophthalmos excisions of conjunctiva are as successful as Naffziger's operation." Malignant exophthalmos may subside without any surgical therapy.

P. C. KRONFELD.

BRACHYDACTYLY AND CONGENITAL SPHEROPHAKIA A SYSTEMIC DISEASE: REPORT OF CASES. O. MARCHESANI, Klin. Monatsbl. f. Augenh. **103:** 392 (Oct.-Nov.) 1939.

Arachnodactyly with ectopia of the lens constitutes Marfan's syndrome. Marchesani reports on a reverse syndrome, brachydactyly coupled with spherophakia (microphakia; congenital globular lens). The genealogy of two families is given. In the first family a boy, aged 8, had typical microphakia, complicated with glaucoma, which could not be conquered by posterior sclerotomy, two cyclodialyses, extracapsular extraction of the lens and discission. The boy was short, with shortened extremities and broad hands, feet, fingers and toes. He was brachycephalic, intelligent and lively. The patient in the second family was a man aged 36, short, stocky and brachycephalic. He had short hands, feet, fingers and toes. The vision of both eyes was reduced to one tenth of the normal. The right lens had been removed. Myopia (18 D.) existed in the left eye; glaucoma with deep excavations of the disks was present in both eyes. One brother and 1 sister showed globular lenses and brachydactyly. Two sisters and 1 brother were free from the syndrome, but the brother's children showed nystagmus, amblyopia and other ocular symptoms.

K. L. STOLL.

OCULAR CHANGES IN POLYCYTHEMIA: REPORT OF A CASE. K. LISCH, Klin. Monatsbl. f. Augenh. **104:** 157 (Feb.) 1940.

A woman aged 41 had a sudden severe headache two years before Lisch's observation. Her left arm became painful and tender to touch, and hemiparesis due to polycythemia with enlargement of the spleen developed soon afterward. The blood pressure was normal. A blood count showed 6,500,000 red cells and 13,750 leukocytes, with 3 per cent eosinophils. No ocular pathologic changes were found, except minor distention of the retinal veins; hyperemia of the conjunctiva was absent. Sudden irritation of the right eye, with severe hyperemia of the conjunctiva of the eyeball and lids, developed a few weeks later. The congestion increased and involved the right side of the forehead. Three weeks later the patient noticed a sudden diminution of vision. The upper temporal retinal artery was compressed near the margin of the disk; a short distance from the disk it was transformed into a white strand and was surrounded by edema of the retina. A short portion of the inferior nasal retinal artery presented a similar appearance. Surrounding it the edema was more distinct than in the upper portion of the fundus. Four days later the symptoms had disappeared except slight edema and the vision had improved to 5/25. The patient felt well again after four months, but atrophy of the right optic nerve had developed and the retinal arteries were narrowed and showed white seams near the disk. The number of red cells had dropped to 4,210,000.

The cause of this phenomenon was supposed to have been spasm of the retinal arteries. According to Mylius, this spasm is a reflex to overloading of the blood with carbon dioxide. The observation of this case is proof of the occurrence of conjunctival irritation in association with polycythemia. Roentgen irradiation, which was used, appears to correct the pathologic changes in the blood and the tendency toward spasm of the blood vessels.

K. L. STOLL.

General Pathology

THE OPTIC PAPILLA IN SEPTIC AND CHRONIC ENDOPHTHALMITIS. H. D. LAMB, Am. J. Ophth. **23:** 408 (April) 1940.

Lamb gives the following summary of his studies on endophthalmitis:

"The optic papilla was studied in 40 eyes with septic endophthalmitis and in 20 eyes with chronic endophthalmitis. In the latter, macrophages instead of pus cells were the prevailing phagocytic cells emigrating into the vitreous. Perivasculitis in the papilla was observed in 53 eyes out of the 60 with endophthalmitis. Both the central retinal arteries and veins in the papilla were equally involved in the perivasculitis. Papilledema occurred in 52 eyes, and in 26 it was moderate or intensive in degree. In regard to cellular infiltration within the optic papilla, 15 eyes with septic endophthalmitis presented a few pus cells or round cells. The remaining 25 eyes with septic endophthalmitis and all of the eyes with chronic endophthalmitis showed practically no inflammatory cells within the papilla. Cellular infiltration is therefore not a

characteristic finding in nonspecific toxic papillitis. On the other hand, phagocytic cells migrating into the vitreous from the optic papilla were noted in all but two eyes with endophthalmitis. This exudation of pus cells and macrophages into the vitreous is accordingly characteristic of nonspecific toxic papillitis. In all eyes with septic endophthalmitis, notable numbers of macrophages were present among the pus cells, anterior to the optic disc. In this situation, also, the macrophages were, with few exceptions, much more numerous in septic than in chronic endophthalmitis, because the intensity of the inflammatory process was greater in the septic cases. As a sequel of toxic papillitis, there occurred the transformation of macrophages in the vitreous near the papilla into fibroblasts. Connective tissue, developed from the latter, produced a membrane of varying thickness on the inner surface of the optic disc. The ophthalmoscopic appearance of inflammatory or postneuritic atrophy is therefore due to this connective-tissue membrane lying on the inner surface of the optic papilla." W. S. REESE.

Glaucoma

THE EFFECT OF SPLENIC EXTRACT ON CHRONIC SIMPLE GLAUCOMA. E. B. ALVIS, Am. J. Ophth. **23:** 529 (May) 1940.

This paper is based on the work of Miller and Paul, who expressed the opinion that glaucoma might be an allergic manifestation. Eight patients with chronic simple glaucoma were selected at random and treated with splenic extract. Alvis concludes that this substance is of dubious value.

W. S. REESE.

INTRAVENOUS INJECTIONS OF SODIUM SALICYLATE SOLUTION FOR ACUTE GLAUCOMA: REPORT OF CASES. I. OHM, Klin. Monatsbl. f. Augenh. **104:** 697 (June) 1940.

Three preoperative measures have proved their merit in the treatment of acute glaucoma: venesection, rest in bed with warming of the lower portion of the body with hot water bottles and intravenous injections of several preparations, the best of which proved to be sodium salicylate solution. This solution was used with good effect as an anodyne before and after operations. The author recommends it in accordance with the present tendency to combat glaucoma not only locally but by general medication. Three cases are reported. The risk of the operation was diminished and its execution facilitated by the injections. Ohm considers it possible to avoid an operation by treatment with the solution in some cases of senile glaucoma. He agrees with Stock that intravenous injection of sodium salicylate solution is effective in the treatment of iritis with increased intraocular tension. No results were obtained in cases of glaucoma which followed thrombosis of the retinal veins, in cases of diabetes or in cases of simple glaucoma.

K. L. STOLL.

Instruments

NEW APPARATUS FOR THE EXTRACTION OF CATARACT BY SUCTION. H. FERRER, Am. J. Ophth. **23**:550 (May) 1940.

Ferrer briefly reviews extracapsular extraction of cataract and from his experience concludes that the suction method is best. He suggests an apparatus that is simple, precise, efficient and inexpensive. This consists of an 80 cc. tank with a vacuum manometer on top and two outlets guarded by valves. By means of tubing these outlets are connected with the erisiphake and a pump by which the desired negative pressure can be created in the tank. Ferrer describes the use of this apparatus and his preoperative and postoperative technic.

W. S. REESE.

Lens

LENS SLIDING IN REMOVAL OF CATARACTS. E. W. ARNDT, Brit. J. Ophth. **24:** 182 (April) 1940.

The author makes a conjunctival bridge with the corneal section. A special forceps is used to seize the capsule at its middle. The lens is then drawn gently and evenly to one side in the horizontal meridian until the zonular ligament gives at the opposite side; the movement next is in the opposite direction until the ligament gives on the opposite side. Then the lens is drawn upward until the ligament ruptures below. The lens is then pushed downward; the last part of the ligament gives at the upper pole, and the edge of the lens presents again, tending to override the iris. As this happens, gentle pressure is made on the sclera under the conjunctival bridge with Bowman's spoon, which up to this point has been lifting the conjunctival bridge up, and the lens is gently slid over the iris by a very light pulling movement directed through the forceps and is easily delivered. When the lens is out, the iris lies back on the surface of the vitreous and the pupil is regular in outline. A few drops of 0.5 per cent solution of physostigmine salicylate is instilled.

W. ZENTMAYER.

SEX INCIDENCE OF CATARACT, WITH SPECIAL REFERENCE TO ITS EXOGENOUS CAUSES. P. W. SALIT, Acta ophth. **18:** 309, 1940.

The author has undertaken a statistical study of all cases of cataract observed at the ophthalmic clinic of the State University of Iowa College of Medicine in the last twenty-nine years. This shows that the frequency of cataract has been increasing more rapidly among women than among men for the last twenty-three years, the period during which women have been most active in changing their mode of living and adopting many of the ways of men.

In order to explain certain periodic high points during these years in the incidence of cataract in both men and women, official weather reports were studied. They showed to the author's satisfaction a remarkable coincidence between the frequency of cataract and summer droughts.

O. P. PERKINS.

Neurology

TEMPORARY ARREST OF THE CIRCULATION TO THE CENTRAL NERVOUS SYSTEM. L. WEINBERGER, M. H. GIBBON and J. G. GIBBON JR., Arch.Neurol. & Psychiat. **43:** 615 (April) 1940.

The authors conducted all their experiments on cats. Circulation of blood to the entire body was abruptly halted by occluding the pulmonary artery with a clamp. After varying intervals the clamp was removed and circulation of blood reestablished. The reappearance of blood flow in the retinal vessels was taken to indicate the end of the period of cerebral circulatory arrest. The time between the clamping of the pulmonary artery and the onset of cessation of convulsions, loss of ophthalmic reflexes, changes in pupil and cessation of respiration were recorded for 19 animals. The shortest period of survival of ophthalmic reflexes was fifteen seconds, and the longest, forty-five seconds. The pupils started to constrict in twenty to sixty-five seconds, and constriction continued until the pupils were the size of pinpoints. They then started to dilate slowly. Dilation began seventy-five to one hundred and five seconds after the onset of circulatory arrest.

At the end of two minutes and thirty seconds of circulatory arrest the animals appeared dead. They were without reflexes. The cornea was wrinkled owing to loss of intraocular tension, and no tears were present. After reestablishment of the circulation, the wrinkled cornea filled out and the blood pressure rose to the preocclusion level. Respiration always returned before the ophthalmic reflexes, the delay in appearance increasing with longer periods of circulatory arrest.

Twenty-four animals were subjected to periods of circulatory arrest ranging from two minutes to ten minutes and fifteen seconds. Arrest of circulation for three minutes and ten seconds or less was tolerated without obvious neurologic disturbances.

Permanent alterations in behavior and psychic function were observed with arrest for more than three minutes and twenty-five seconds. After six minutes of circulatory arrest, vision and sensation suffered some degree of permanent injury. After seven minutes and thirty-six seconds there were permanent and practically complete dementia, blindness, serious sensory and auditory defects, motor and postural defects and reflex abnormalities. When circulation was interrupted eight minutes and forty-five seconds or longer, life could not be restored for more than a few hours. The pathologic effects of the arrest of circulation are presented in the May issue of the *Archives of Neurology and Psychiatry,* page 961.

R. IRVINE.

THE EXTERNAL GENICULATE BODIES. W. J. GERMAN and B. S. BRODY, Arch. Neurol. & Psychiat. **43:** 997 (May) 1940.

Lesions of the posterior portion of the calcarine cortex are followed by degeneration of the cells occupying the macular representation in the external geniculate body. Therefore, if the macula is bilaterally represented in the calcarine cortex, unilateral excision or destruction of the cortical macular representation should result in bilateral secondary

degenerative changes in the macular portion of the external geniculate body. The authors report a case history bearing on these observations and conclude as follows:

1. No evidence of secondary degenerative changes could be found in the contralateral geniculate body ten weeks after subtotal occipital lobectomy and fifteen weeks after perimetric demonstration of macula-sparing hemianopia. Extensive secondary degenerative changes were identified in the homolateral external geniculate body.

2. The absence of secondary degenerative changes in the contralateral external geniculate body suggests that bilateral cortical macular representation does not occur in man unless collateral branching is present in the macular fibers of the optic radiation.

R. IRVINE.

Retina and Optic Nerve

CEREBRAL FAT EMBOLISM WITH RECOVERY AND INVOLVEMENT OF THE CENTRAL RETINAL ARTERY. J. J. EVANS, Brit. J. Ophth. **24**: 614 (Dec.) 1940.

The patient was a man 23 years of age who had suffered a road injury. He was drowsy but not unconscious. There were fractures of the right tibia and fibula, a star-shaped fracture of the right patella and an oblique fracture of the right ulna. On the fourth day after the accident there was diffuse edema of the retina over the whole of the posterior poles, suggestive of shallow retinal detachment, with the retinal vessels standing out prominently. The edema was more pronounced in the macular area, where also three slightly crescentic areas of intensified pallor were noticeable; one of these whiter areas appeared to be in the deeper layers of the retina.

In the right eye, well outside and below the periphery, there were two large subhyaloid hemorrhages, each measuring more than 1 disk in diameter. In the left eye a similar but smaller hemorrhage was seen near the periphery on the nasal side. There was no complaint of disturbance or defect in vision. About seven weeks after the injury, except for remnants of the hemorrhage, the appearance of both fundi was absolutely normal. The visual acuity equaled 6/6 in each eye.

The article is illustrated.

W. ZENTMAYER.

COMPARISON BETWEEN GONIN'S AND WEVE'S METHOD FOR LOCALIZING RETINAL TEARS. H. SERR, Arch. f. Ophth. **141**: 655, 1940.

In 17 cases of idiopathic retinal detachment the author localized the tear before the operation with Gonin's method (estimation of the parallel and the meridian with the ophthalmoscope) and during the operation with Weve's method (indirect ophthalmoscopic visualization of the tear, which produces a well defined spot of light on the sclera overlying the tear. In the center of this spot of light a test puncture was made with a fine diathermic needle electrode, and its position with regard to the tear was ascertained ophthalmoscopically). Except in 3 cases of large bullous detachment the results of Gonin's method came within $\pm$ 1.5 mm. of the actual position of the tear. With Weve's

method the tear was localized accurately (the error being 0) in 13 of the total of 17 cases. In order to carry out accurate ophthalmoscopic procedures during the operation the cornea must be kept as clear as possible. The author, therefore, uses no instillation anesthesia but confines himself to subconjunctival injection of procaine hydrochloride.

P. C. KRONFELD.

Trachoma

THE EFFECT OF TARTAR EMETIC [ANTIMONY AND POTASSIUM TARTRATE] ON THE COURSE OF TRACHOMA. L. A. JULIANELLE, J. F. LANE and W. P. WHITTED, Am. J. Ophth. **22**:1390 (Dec.) 1939.

Julianelle, Lane and Whitted draw the following conclusions after treating 22 patients, 18 of whom were Indians, with antimony and potassium tartrate:

"1. Tartar emetic used as described in the treatment of trachoma has little effect when the disease is essentially conjunctival.

"2. When, however, conjunctival hyperplasia is sufficiently extensive to warrant grattage, tartar emetic administered according to the short schedule is a helpful, supplementary procedure.

"3. Measured by clinical improvement and gain in visual acuity, the drug has a definite, beneficial effect on corneal trachoma, even rendering the disease asymptomatic.

"4. In more than half the patients observed in this study, tartar emetic was patently toxic, inducing coughing, muscular stiffness and soreness, and in one case articular pain, in another vomiting, and in still another thrombosed veins."

W. S. REESE.

Tumors

ON THE QUESTION OF PRIMARY GLIOMA OF THE OPTIC NERVE: REPORT OF A CASE. F. WAGNER, Klin. Monatsbl. f. Augenh. **103**:606 (Dec.) 1939.

A girl aged 5 years showed exophthalmos of the left eye for two and one-half years prior to consultation. A tumorous prominence was noted in the nasal portion of the retina, and closely adjoining it were a number of small choroidal foci and a large one, as well as some preretinal hemorrhages. The roentgenogram revealed widening of the optic canal; the sella appeared normal. Neurologic examination and an encephalogram showed no signs of intracranial involvement by the tumor. The child died from diphtheria twelve days after admission to the hospital.

Histologic examination of the left eye, with the tumor, the optic nerve and the chiasm, is recorded in detail. The tumor was a typical primary glioma of the optic nerve. The identity of glioma and myxoma, myxosarcoma and fibrosarcoma is discussed. The terms gliomatosis and fibrogliomatosis of the optic nerve are considered incorrect by the author.

K. L. STOLL.

DERMOID (OIL) CYST OF THE ORBIT. W. B. BORLEY, Am. J. Ophth. **22**:1355 (Dec.) 1939.

Borley reports the case of a 27 year old man who complained of lacrimation of the left eye since childhood. His mother stated that at the age of 1 year a swelling below the left eye was incised. Examination revealed a wider left palpebral fissure, and on eversion of the left lower lid an atrophic conjunctiva was revealed in the medial portion of the cul-de-sac, with a considerable overlying scar tissue. In the middle of this scar tissue a fistulous tract was found, which on probing extended into the orbit posterolaterally for 2 or 3 cm. When the lower lid was pressed an oily secretion exuded from the fistula. Roentgen examination revealed a smooth oval object on the floor of the left orbit, which might be a calcified abscess, a cyst or a foreign body. Iodized poppyseed oil was then used, and a diagnosis of cyst (probably dermoid) was made. This was verified at operation when the cyst was removed after injection of methylthionine chloride U. S. P. (methylene blue). It was found to contain a tooth. Healing was uneventful. A diagnosis of dermoid cyst was made from the removed specimen.

W. S. REESE.

CORRECTION

The article entitled "Chronic Dacryocystitis: Its Causation and Treatment" by Dr. H. M. Traquair, of Edinburgh, Scotland, was published (ARCH. OPHTH. **26:** 165 [Aug.] 1941) without waiting for return of the author's proof. The following changes made in the author's proof should be noted:

"Incidence" is substituted for "predilection" in several places in which the terms "social predilection" and "sex predilection" appeared.

At the bottom of page 166, in the sentence "In 2 cases it was associated with local injury," "it" is changed to "the dacryocystitis."

The references in footnotes 11 and 12, deleted from the Archives because not completed, are as follows:

11. Stock, W.: Die Pathologie der Tränenorgane, in Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 2, Leipzig, Wilhelm Engelmann, 1925, vol. 9, pt. 2, chap. 15.

12. de Schweinitz, G. E.: Diseases of the Eye, ed. 10, Philadelphia, W. B. Saunders Company, 1924.

The next to the last sentence on page 172 is modified to read: "No evidence has been recorded as to whether infants who have been cured of congenital dacryocystitis have the adult form in later years or themselves have affected children or children who are unaffected at birth but who become affected in adult life."

Society Transactions

EDITED BY DR. W. L. BENEDICT

DETROIT OPHTHALMOLOGICAL SOCIETY

PARKER HEATH, M.D., *President*

EDMOND L. COOPER, M.D., *Recorder*

April 24, 1941

Contributions to Ophthalmic Practice: I. Interpretation of Laboratory Findings Relative to Cellular Elements of Blood. DR. FRANK HARTMAN.

The interpretation of laboratory findings depends among other things on the honesty of the laboratory technician and on the methods and instruments used in making the tests. Unfortunately, the "sink test" is still made by some inefficient and dishonest laboratory technicians on specimens of urine and even on specimens of blood taken to determine the Wassermann reaction. The reports of laboratories employing such technicians can of course not be discounted too much. In many laboratories cheap instruments, especially those imported from Japan, are the source of considerable error. For instance, many inaccurate reports of red and white blood cell counts are due to cheaply made imported pipets.

With many tests the method used must be understood in order properly to evaluate results. For example, the measurement of hemoglobin with a hemoglobinometer or with any of the various testing papers is not correct, since the result is given in "per cent." Measurement of hemoglobin should be according to the number of milligrams per hundred cubic centimeters, since a report that the hemoglobin content is "100 per cent" may mean that it is anywhere from 13 to 17 mg. per hundred cubic centimeters.

The method used in making blood smears for differential counts of white blood cells is also a common source of error. Many laboratory technicians do not know how to spread a drop of blood on a glass slide properly. If a smear is improperly made, many of the larger cells are crowded to the edges of the slide and when the differential count is made by examining only the middle of the slide the larger cells are not seen.

Contribution to Ophthalmic Practice: II. The Interpretation of Laboratory Findings Relative to the Chemistry of the Blood. DR. O. E. GAEBLER.

The methods used in determining the normal values of blood constituents should be thoroughly understood by any one attempting to interpret results. Different methods may give different normal values, and the units of measurement used must be considered. In reporting the blood urea content a laboratory may give the result in terms of milligrams of urea nitrogen per hundred cubic centimeters of blood or

in terms of milligrams of actual urea per hundred cubic centimeters of blood, depending on the method used. In England results of determinations of urea in the blood are reported in terms of milligrams of actual urea per liter of blood.

The conditions under which the specimen of blood to be examined was drawn are important in considering the laboratory findings. For instance, previous dietary therapy and the time which has elapsed between the last meal and the drawing of the blood for the determination have an influence on the sugar content.

Some elements of the blood, such as calcium and sodium, are unevenly distributed between the blood plasma and the blood cells, but the ratio is not maintained after a specimen has been drawn. Therefore, the determination of these constituents should be done as soon as possible.

Everything else being equal, the laboratory report on the chemistry of the blood should be interpreted in the light of the clinical data, since the level of a blood constituent may vary in different stages of the disease. By way of illustration, consider hyperthyroidism. During the period in which the thyroid gland is being depleted of iodine the amount of this substance in the blood is high. After the thyroid has lost its iodine the blood level returns to normal although the symptoms of hyperthyroidism continue undiminished. One must realize that chemical examination of the blood may tell the clinician something about what he wants to know but not everything.

Use of Dimitry's Suction Syringe in Operation for Cataract (Colored Motion Picture). DR. EDMOND L. COOPER.

I have collected a series of 37 cases of cataract removed with Dimitry's suction apparatus. Some of the patients were from private practice, and some were from the outpatient departments of Harper Hospital and Receiving Hospital. Those from the hospitals were operated on by various members of the staffs.

In evaluating the results in this series one should take into consideration the fact that the operations were performed by a number of surgeons of varying degrees of skill who used slightly different technics. Probably the results would have been more impressive had one surgeon been able to perform all the operations.

Of 37 cases, vitreous was lost in 6, or in 16.2 per cent. Two cases should perhaps be excluded from the series, since they were cases of dislocation of the lens. If these are omitted, the records show loss of vitreous in 4 cases, or in 11.4 per cent.

The lens capsule was ruptured in 3 cases. It was felt in each case that the rupture occurred because too much traction had been applied to the lens. It was found that little traction is necessary when Dimitry's suction syringe is used, since the sucking action of the instrument itself is sufficient.

Postoperative complications in this series were limited to prolapse of the iris in 1 case and prolapse of the vitreous in 1.

Of the 32 cases in which postoperative records of the visual acuity were available, the visual acuity was 20/20 in 11, 20/30 in 7, 20/40 in 4, 20/50 in 3, 20/70 in 2 and 20/100 or worse in 5 because of complications.

Book Reviews

Principles and Practice of Ophthalmic Surgery. By Edmund B. Spaeth, M.D. Second edition. Price, $10. Pp. 886, with 1,149 figures and 6 colored plates. Philadelphia: Lea & Febiger, 1941.

In the second edition of this valued book on ophthalmic surgery the author has added little that is new. Most of the chapters remain essentially the same. Paragraphs have been rewritten here and there and minor clarifying changes in the arrangement of the subject matter made. So many excellent illustrations have been added that one regrets the retention of a few inferior ones. In the chapter on the arbit there is much new material on the ocular manifestations of neurofibromatosis. A description of the Wheeler type of pressure bandage as published by Pfeiffer is the important addition to the chapter on plastic surgery. White's statistics on the frequency and importance of vertical deviations and Casten's transplantation of the lateral rectus muscle to supplant a paretic vertical one constitute the new material in the chapter on ocular muscles. In view of the present status of chemotherapy for trachoma the reviewer is surprised to find that the author still considers "the surgical indications for lid surgery in trachoma as imperative whenever corneal involvement develops." The chapters on intraocular surgery remain practically unchanged except for additional references and illustrations designed to bring these subjects up to date.

The excellent format of the first edition is maintained, or even surpassed. This work will be found a comprehensive and effective guide to all conditions for which ophthalmic surgery is required, but it is too all inclusive for the inexperienced surgeon. This edition, brought out two years after the first, is abreast of the times and worthy of study by every ophthalmic surgeon.

JOHN H. DUNNINGTON.

News and Notes

PERSONAL

Dr. John E. Weeks.—A dinner will be given in honor of Dr. John E. Weeks on the occasion of the centennial of the College of Medicine of New York University on Monday, Oct. 6, 1941, at the Union Club, New York.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 17 Horseferry Rd., London, England.

Pan-American Congress of Ophthalmology

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretaries: Dr. Conrad Berens, 35 E. 70th St., New York. Dr. M. E. Alvaro, 1511 Consolacao, São Paulo, Brazil.

FOREIGN

All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

British Medical Association, Section on Ophthalmology

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.
Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

Hungarian Ophthalmological Society

President: Prof. H. G. Ditroi, Szeged.
Assistant Secretary: Dr. Stephen de Grosz, University Eye Hospital, Maria ucca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Place: Birmingham and Midland Eye Hospital.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

NORTH OF ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. A. MacRae, 6 Jesmond Rd., Newcastle-upon-Tyne, England.
Secretary: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Place: Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Liverpool and Sheffield, in rotation. Time: October to April.

OPHTHALMOLOGICAL SOCIETY OF AUSTRALIA

President: Dr. A. James Flynn, 135 Macquarie St., Sydney.
Secretary: Dr. D. Williams, 193 Macquarie St., Sydney.

OPHTHALMOLOGICAL SOCIETY OF EGYPT

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the Secretary, Dr. Mohammed Khalil.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Secretary: Mr. L. H. Savin, 7 Queen St., London, W. 1, England.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Rd., Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. A. J. Ballantyne, 11 Sandyford Pl., Glasgow, C. 3, Scotland.
Secretary: Dr. C. Dee Shapland, 15 Devonshire Pl., London, W. 1, England.

SOCIEDAD OFTALMOLOGIA DEL LITORAL, ROSARIO (ARGENTINA)

President: Prof. Dr. Carlos Weskamp, Laprida 1159, Rosario.
Secretary: Dr. Juan M. Vila Ortiz, Córdoba 1433, Rosario.
Place: Rosario. Time: Last Saturday of every month, April to November, inclusive.
All correspondence should be addressed to the President.

SOCIEDADE DE OPHTALMOLOGIA E OTO-RHINO-LARYNGOLOGIA DA BAHIA

President: Dr. Francisco Ferreira, Pitangueiras 15, Brotas, S. Salvador, Brazil.
Secretary: Dr. Adroaldo de Alencar, Brazil.
All correspondence should be addressed to the President.

SOCIETÀ OFTALMOLOGICA ITALIANA

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome.
Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome.

SOCIÉTÉ FRANÇAISE D'OPHTALMOLOGIE

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 Ill tr., Stockholm, Sö.

TEL AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Lawrence T. Post, 508 N. Grand Blvd., St. Louis, Mo.
Secretary: Dr. Derrick Vail, 441 Vine St., Cincinnati.
Place: Atlantic City. Time: June 8-12, 1942.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. Frank R. Spencer, Physicians' Bldg., Boulder, Colo.
President-Elect: Dr. Ralph I. Lloyd, 14–8th Ave., Brooklyn.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Chicago. Time: Oct. 19-24, 1941.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Allen Greenwood, 82 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.

ASSOCIATION FOR RESEARCH IN OPHTHALMOLOGY, INC.

Chairman: Dr. John Evans, 23 Schermerhorn St., Brooklyn.
Secretary-Treasurer: Dr. C. S. O'Brien, University Hospital, Iowa City.

CANADIAN MEDICAL ASSOCIATION, SECTION ON OPHTHALMOLOGY

President: Dr. Alexander E. MacDonald, 170 St. George St., Toronto.
Secretary-Treasurer: Dr. L. J. Sebert, 170 St. George St., Toronto.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. J. Vaillancourt, 46 St. Louis St., Quebec.
Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. Mason H. Bigelow, 1790 Broadway, New York.
Secretary: Miss Regina E. Schneider, 1790 Broadway, New York.
Executive Director: Mrs. Eleanor Brown Merrill, 1790 Broadway, New York.

SECTIONAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Charles W. Barkhorn, 223 Roseville Ave., Newark.
Secretary: Dr. William F. McKim, 317 Roseville Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. J. V. May, 1703 Main St., Marinette.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marinette. Time: November 1941.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Rowland, 84 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. Trygve Gundersen, 243 Charles St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. Isaac H. Jones, 635 S. Westlake Ave., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Spencer S. Howe, 103 E. Holly St., Bellingham, Wash.
Secretary-Treasurer: Dr. Barton E. Peden, 419 Stimson Bldg., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. W. H. Elmer, 321 W. State St., Rockford, Ill.
Secretary-Treasurer: Dr. Harry R. Warner, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. M. Kessler, 311 Center Ave., Bay City, Mich.
Secretary-Treasurer: Dr. J. H. Curts, 330 S. Washington Ave., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. C. Davis, 1615 Howard St., Omaha.
Secretary-Treasurer: Dr. J. E. Dvorak, 408 Davidson Bldg., Sioux Falls, S. D.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN ACADEMY OF EYE, EAR, NOSE AND THROAT

President: Dr. Franklin P. Maury, Professional Bldg., Tucson, Ariz.
Secretary: Dr. A. E. Cruthirds, 1011 Professional Bldg., Phoenix, Ariz.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. W. M. Dodge, 716 First National Bank Bldg., Battle Creek.
Secretary-Treasurer Dr. Kenneth Lowe, 25 W. Michigan Ave., Battle Creek.
Time: Last Thursday of September, October, November, March, April and May.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. H. Bailey, 29 S. Oakland Ave., Sharon.
Secretary-Treasurer: Dr. J. McClure Tyson, Deposit Nat'l Bank Bldg., DuBois.

STATE

ARKANSAS STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. R. R. Kirkpatrick, 6th and Walnut Sts., Texarkana, Ark.
Secretary-Treasurer: Dr. Raymond C. Cook, 701 Main St., Little Rock.

COLORADO OPHTHALMOLOGICAL SOCIETY

President: Dr. William M. Bane, 1612 Tremont Pl., Denver.
Secretary: Dr. Harry Shankel, Republic Bldg., Denver.
Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. Edward N. DeWitt, 836 Myrtle Ave., Bridgeport.
Secretary-Treasurer: Dr. Henry L. Birge, 179 Allyn St., Hartford.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. E. N. Maner, 247 Bull St., Savannah.
Secretary-Treasurer: Dr. C. K. McLaughlin, 567 Walnut St., Macon.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. F. McK. Ruby, Union City.
Secretary: Dr. Edwin W. Dyar Jr., 23 E. Ohio St., Indianapolis.
Place: French Lick. Time: First Wednesday in April.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. J. K. Von Lackum, 117–3d St. S.E., Cedar Rapids.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

Louisiana-Mississippi Ophthalmological and Otolaryngological Society

President: Dr. Henry N. Blum, 912 American Bank Bldg., New Orleans.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Robert H. Fraser, 25 W. Michigan Ave., Battle Creek.
Secretary: Dr. R. G. Laird, 114 Fulton St., Grand Rapids.

Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. Erling Wilhelm Hansen, 78 S. 9th St., Minneapolis.
Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. A. L. Hammerel, 208 N. Broadway, Billings.
Secretary: Dr. Fritz D. Hurd, 309 Medical Arts Bldg., Great Falls.

Nebraska Academy of Ophthalmology and Otolaryngology

President: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. John Peterson, 1307 N St., Lincoln.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. Edgar P. Cardwell, 47 Central Ave., Newark.
Secretary: Dr. Arthur E. Sherman, 243 S. Harrison St., East Orange.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Searle B. Marlow, 109 S. Warren St., Syracuse.
Secretary: Dr. C. Stewart Nash, 277 Alexander St., Rochester.

North Carolina Eye, Ear, Nose and Throat Society

President: Dr. M. R. Gibson, Professional Bldg., Raleigh.
Secretary: Dr. Vanderbilt F. Couch, 105 W. 4th St., Winston-Salem.

North Dakota Academy of Ophthalmology and Oto-Laryngology

President: Dr. A. E. Spear, Dickinson.
Secretary-Treasurer: Dr. F. L. Wicks, 516–6th St., Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Paul Bailey, 833 S. W. 11th Ave., Portland.
Secretary-Treasurer: Dr. R. S. Fixott, 1020 S. W. Taylor St., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Roderick Macdonald, Rock Hill.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.
Place: Columbia Hotel, Columbia. Time: November 1941.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Wesley Wilkerson, 700 Church St., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. E. L. Goar, 1300 Walker Ave., Houston.
Secretary: Dr. Dan Brannin, 929 Medical Arts Bldg., Dallas.
Place: San Antonio. Time: December 1941.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. Rowland H. Merrill, 1010 First National Bank Bldg., Salt Lake City.
Secretary-Treasurer: Dr. Earl H. Phillips, 628 Judge Bldg., Salt Lake City.
Place: University Club, Salt Lake City. Time: 7:00 p. m., third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. George G. Hawkins, Newport News.
Secretary-Treasurer: Dr. Guy Fisher, 3 E. Beverley St., Staunton.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

AKRON ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George E. Black, 7 W. Bowery St., Akron, Ohio.
Secretary-Treasurer: Dr. C. R. Andersen, 106 S. Main St., Akron, Ohio.
Time: First Monday in January, March, May and November.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Stacy C. Howell, 144 Ponce de Leon Ave. N. E., Atlanta, Ga.
Secretary: Dr. Lester A. Brown, 478 Peachtree St. N. E., Atlanta, Ga.
Place: Grady Hospital. Time: 6:00 p. m., second Wednesday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Ernst Bodenheimer, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. Thomas R. O'Rourk, 104 W. Madison St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m. fourth Thursday of each month from October to March.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. Luther E. Wilson, 919 Woodward Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. Maurice Wieselthier, 1322 Union St., Brooklyn.
Secretary-Treasurer: Dr. Harold F. Schilback, 142 Joralemon St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. Douglas Chamberlain, Chattanooga Bank Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Sanford Gifford, 720 N. Michigan Ave., Chicago.
Secretary-Treasurer: Dr. Vernon M. Leech, 55 E. Washington St., Chicago.
Place: Chicago Towers Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati General Hospital Ophthalmology Staff

Chairman: Dr. D. T. Vail, 441 Vine St., Cincinnati.
Secretary: Dr. A. A. Levin, 441 Vine St., Cincinnati.
Place: Cincinnati General Hospital. Time: 7:45 p. m., third Friday of each month except June, July and August.

Cleveland Ophthalmological Club

Chairman: Dr. W. J. Abbott, 10515 Carnegie Ave., Cleveland.
Secretary: Dr. L. V. Johnson, 2065 Adelbert Rd., Cleveland.
Time: Second Tuesday in October, December, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Francis H. Adler, 313 S. 17th St., Philadelphia.
Clerk: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. C. D. Postle, 240 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. Hugh C. Thompson, 289 E. State St., Columbus, Ohio.
Place: The Neil House. Time: 6 p. m., first Monday of each month.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. F. K. Stroud, 416 Chaparral St., Corpus Christi, Texas.
Secretary: Dr. Arthur Padilla, 414 Medical Professional Bldg., Corpus Christi, Texas.
Time: Second Friday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. L. A. Nelson, 4105 Live Oak St., Dallas, Texas.
Secretary: Dr. S. F. Harrington, 921 Medical Arts Bldg., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. H. C. Schmitz, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Byron M. Merkel, 604 Locust St., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Leland F. Carter, 1553 Woodward Ave., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Detroit Ophthalmological Society

President: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Secretary: Dr. Leland F. Carter, 1553 Woodward Ave., Detroit.
Place: Club rooms of Wayne County Medical Society. Time: Third Thursday of each month from November to April, inclusive.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. L. A. Hulsebosch, 191 Glen St., Glen Falls.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. W. R. Thompson, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. A. E. Jackson, 602 W. 10th St., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Ophthalmological and Oto-Laryngological Section

President: Dr. Wallace W. Ralston, 1304 Walker Ave., Houston, Texas.
Secretary: Dr. William J. Snow, 708 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. John I. Garret, 57 Stokes Bldg., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Homer Beal, 1103 Grand Ave., Kansas City, Mo.
Secretary: Dr. Desmond Curran, Federal Reserve Bank Bldg., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Harold Snow, 614 S. Pacific Ave., San Pedro, Calif.
Secretary-Treasurer: Dr. Oliver R. Nees, 508 Times Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Otolaryngology

President: Dr. Harold Mulligan, 1680 N. Vine St., Los Angeles.
Secretary-Treasurer: Dr. Colby Hall, 1136 W. 6th St., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye and Ear Society

President: Dr. Joseph S. Heitger, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. W. Fish, 321 W. Broadway, Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. E. J. Cummings, 1835 I St. N. W., Washington.
Secretary: Dr. P. S. Constantinople, 1835 I St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month from September to May.

Milwaukee Oto-Ophthalmic Society

President: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.
Secretary-Treasurer: Dr. Ralph T. Rank, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

Montgomery County Medical Society

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. J. Rosenbaum, 1396 Ste. Catherine St. W., Montreal, Canada.
Secretary: Dr. L. Tessier, 1230 St. Joseph Blvd. E., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Secretary: Dr. Guy Maness, Medical Arts Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

New Haven Ophthalmological Society

President: Dr. William H. Ryder, 185 Church St., New Haven, Conn.
Secretary: Dr. Frederick A. Wies, 255 Bradley St., New Haven, Conn.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Secretary: Dr. Mercer G. Lynch, 1018 Maison Blanche Bldg., New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to May.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Algernon Reese, 73 E. 71st St., New York.
Secretary: Dr. Brittain Payne, 896 Madison Ave., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

NEW YORK SOCIETY FOR CLINICAL OPHTHALMOLOGY

President: Dr. James W. Smith, 1016–5th Ave., New York.
Secretary: Dr. Benjamin Esterman, 983 Park Ave., New York.
Place: Squibb Hall, 745–5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

OKLAHOMA CITY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. R. E. Leatherock, Cushing, Okla.
Secretary: Dr. Harry C. Ford, 1014 Medical Arts Bldg., Oklahoma City.
Place: University Hospital. Time: Second Tuesday of each month from September to May.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Harold Gifford, 1620 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

PASSAIC-BERGEN OPHTHALMOLOGICAL CLUB

President: Dr. L. Markowitz, 16 Church St., Paterson, N. J.
Secretary-Treasurer: Dr. A. John Reinhorn, 302 Broadway, Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Secretary: Dr. Wilfred E. Fry, 1819 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Edward A. Weisser, 119–5th Ave., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. W. F. Bryce, Medical Arts Bldg., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. E. J. Avery, 11 N. Goodman St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. William M. James, 508 N. Grand Blvd., St. Louis.
Secretary: Dr. H. Rommel Hildreth, 823 Metropolitan Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Dan Russell, 705 E. Houston St., San Antonio, Texas.
Secretary-Treasurer: Dr. P. G. Bowen, 315 Camden St., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Fred Boyle, 490 Post St., San Francisco.
Secretary: Dr. Frank Hand, 450 Sutter St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. David C. Swearingen, Slattery Bldg., Shreveport, La.
Secretary-Treasurer: Dr. Kenneth Jones, Medical Arts Bldg., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Louis A. Parsell, 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. Robert L. Pohl, 407 Riverside Ave., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. F. R. Webster, State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. John R. Myers, State Tower Bldg., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

TOLEDO EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. J. E. Minns, 316 Michigan St., Toledo, Ohio.
Secretary: Dr. John D. Skow, 2001 Collingwood Blvd., Toledo, Ohio.
Place: Toledo Club. Time: Each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. W. R. F. Luke, 316 Medical Arts Bldg., Toronto, Canada.
Secretary: Dr. W. T. Gratton, 216 Medical Arts Bldg., Toronto, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. E. Leonard Goodman, 1801 I St. N. W., Washington, D. C.
Secretary-Treasurer: Dr. Sterling Bockoven, 1752 Massachusetts Ave. N.W., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 7:30 p. m., first Monday in November, January, March and April.

WILKES-BARRE OPHTHALMOLOGICAL SOCIETY

Chairman: Each member in turn.
Secretary: Dr. Samuel T. Buckman, 70 S. Franklin St., Wilkes-Barre, Pa.
Place: Office of chairman. Time: Last Tuesday of each month from October to May.